Sustainable Transport @ MIT

Final Report

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1 Introduction

President Susan Hockfield has expressed her intention to establish Massachusetts Institute of Technology (MIT) as a leader in reducing energy consumption by establishing the Energy Research Council. Many have seen the following graph, originally from a student's thesis, used by the Council.

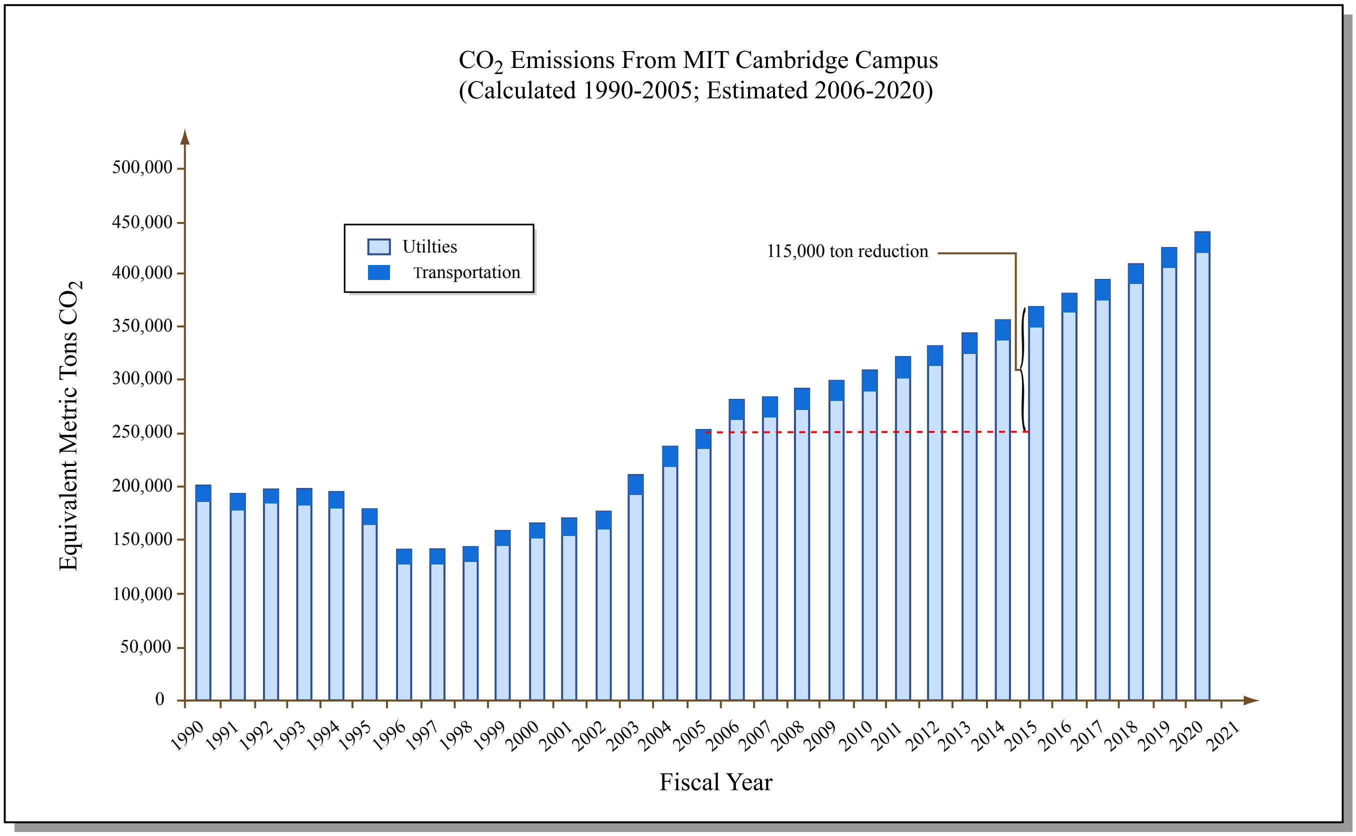


Figure by MIT OCW.

Source: The MIT Energy Research Council http://web.mit.edu/erc/campus/index.html[1]

This graph establishes transportation as a component of the effort to reduce MIT's carbon footprint. Tiffany Groode, the author of the thesis in which this graph first appeared, estimated that commuters account for about ten percent of emissions caused by MIT, though many believe the percentage of carbon dioxide emissions caused by transportation to be higher than this estimate. According to the Environmental Protection Agency, in the U.S., the transportation sector's contribution to carbon dioxide emissions is greater than one-quarter of all emissions.[2]

MIT has already made considerable strides in transportation demand management through policies that encourage commuting to its very accessible urban campus via transit. MIT has a progressive transit subsidy program and voluntarily limits the number of parking spots on campus. This limit has been at least partly due to MIT's relationship with the City of Cambridge and the administration's desire to prevent a hard cap from being imposed on its parking spots by the City. However, this report attempts to take demand management a step further with a systematic approach to transportation policy that is effective and sustainable.

[1] Based on a student thesis: Groode, Tiffany Amber. A Methodology for Assessing MIT's Energy Use and Greenhouse Gas Emissions. May 2004.
[2] United States Environmental Protection Agency. Calculating Emissions of Greenhouse Gases: Key Facts and Figures. February 2005.

Effective and sustainable transportation policy should minimize the environmental impact of commuting behavior to campus by inducing a shift to less energy intensive modes of commuting. Policy can achieve this through the provision of viable and attractive alternatives. Therefore, the policy recommendations in this report provide a range of options for the MIT community, including the choice to give up parking in the highest demand lots in order to continue to park at the same, or even a lower rate. The net effect of the following recommendations should be a reduction in demand for parking by those who can reasonably take other modes, which will carry forward into the future as new housing location decisions might be made to better take advantage of transit and other commuting options.

The goal of inducing a shift in commuting behavior to transit is not meant to punish those who must drive alone to get to campus, because decisions to purchase housing in certain locations have been so far based on a different transportation policy that provided cheap and convenient parking on campus. Results from the 2006 MIT Transportation Survey indicate that while many staff (rather than students) have chosen to live at significant distances from campus, some in areas with no reasonable transit option, many do in fact have a viable transit option, or could carpool. See 6.1, Appendix 1 for an analysis of the location choices that have so far been made by the MIT community and the basis for our estimate of the number of drivers who could feasibly switch to taking transit, an important factor later in our analysis.

Effective transportation policy should optimize the provision of parking options in strategic locations and the incentives for the use of public transport while carefully considering the costs, including monetary expenditures and negative impacts on quality of life. A sustainable transportation plan must be environmentally friendly, financially sound, and strongly consider equity issues. Although MIT is attempting to reduce the parking subsidy by raising parking prices 11 percent each year, the cost of providing parking to driving commuters is rising dramatically along with MIT's carbon dioxide emissions, an outcome indicative of unsustainable, inequitable, and counterproductive incentives. Instead, sustainable transportation policy involves movement towards equalizing the subsidy for parking and transit to offer an incentive to take transit. This report is a long-term vision to improve MIT's status as a cutting edge institution dedicated to sustainability as well as the provision of valued amenities to the current and future MIT community.

The following are four core strategies motivating the following policy proposals:

a) Accept the current MIT policy treating parking as an asset to the university, while making it more financially feasible by reducing the subsidy to a minimal amount necessary to meet parking needs of the MIT community (which could change due to demand management), or at least to the level that other benefits are subsidized.
b) Reduce MIT's transportation carbon footprint while retaining mobility and flexibility of access by encouraging commuters to switch to carpooling, transit, walking, and bicycling.
c) Maintain choices for all types of employees and students on campus, respecting past location decisions. Ensure that, at least initially, there is a parking option for

drivers that makes them no worse off financially than they would have been with the 11 percent increase.

d) Establish MIT as leader, setting an example in planning for sustainability.

In this report we propose effective and sustainable parking policy that addresses parking prices, transit subsidies, and shuttle service. We proposal a Universal Transportation Program that addresses the issues so far laid out in this introduction.

We first summarize our recommendations and the major components of the Universal Transportation Program in Section 2. This is followed by a description of the current state of the parking, transit, and shuttle systems, relative revenues and investments, and issues that exist at the university in Section 3. We then make various policy proposals regarding parking prices, parking inventory, transit subsidies, shuttle operations, and land use opportunities in Section 4. We support our proposals with extensive financial analysis supported by a transportation models to determine the feasibility of alternatives. We analyze eight different potential formats of the parking and transit components of our Universal Transportation Program in greater detail, predicting the revenues and changes in commuting behavior resulting from each scenario. The resulting mode switch ranges from a five to 13 percent decrease in MIT commuters who drive alone to reach campus. Finally, we assess these eight scenarios according to their induced change in drive alone behavior, cost to MIT, and equity, the results of which are presented in Section 5.

2 Overall Recommendations

We propose a general structure wherein the MBTA and parking programs are combined into a single Transportation program, in conjunction with modifications to the shuttle program. In this Unified Transportation Program:

- All members of the MIT community are eligible to receive a mobility pass for a low monthly rate of $15.
- The new mobility pass provides users with an MBTA LinkPass (unlimited use of the bus and subway), Commuter Rail subsidy of up to 100 percent, and an occasional parking permit.
- Any time a recipient parks on campus they pay a daily rate which is differentiated by lot, with lots in higher demand having higher daily prices.
- Students and employees are able to opt out of the program during an open enrollment period, most likely during the first month of the Fall semester.
- No daily charge would be incurred for parking on the weekends with the mobility pass.

The program would be structured so that parking revenue would be increased over the current pricing structure, but that all individuals would have the opportunity to pay the same amount, or less than they are currently paying by parking at lower demand lots.

Some individuals would have exemptions from the daily rates and instead would be issued annual parking permits as in the current system. Students and staff who live on campus, motorcycles, carpools, and professors emeritus would still be issued annual permits. Student and staff residents, carpools and motorcycles would also be eligible for a mobility pass and the cost would be incorporated into their annual parking rate.

We have created a model that estimates the cost of this proposed program, the results of which are presented in Section 5, Analysis of Alternatives.

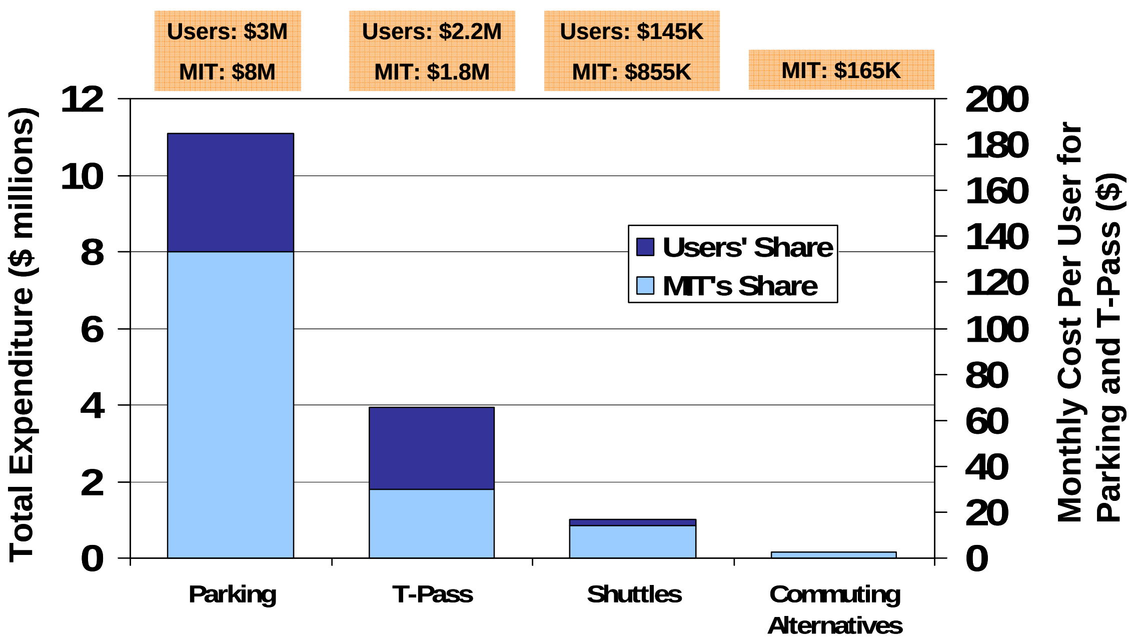
3 Current State

The recommendations outlined in Section 2 are based on a thorough analysis of the current state of transportation on MIT's campus today. We begin with an introduction to the Fiscal Year 2007 MIT Parking and Transportation Budget. Then, we look at each mode individually, beginning with the parking policies, followed by transit, and concluding with shuttles. In each of these subsections, we outline current supply and usage, pricing, costs, subsidies, and other issues of concern. We conclude with a discussion of the various sources of funding for these policies.

The FY07 MIT Parking and Transportation Budget is $16,225,000, with $11 million, or 68 percent, dedicated to parking. Of this $11 million, $3 million is paid for by the drivers themselves, while the balance is covered by MIT through its various benefit pools. An additional $4 million, or 25 percent, is spent on MBTA T-Passes. Transit users cover slightly more than half of those costs with MIT picking up the rest.

The cost of providing each individual parking space averages out to $190 per month, while the cost of providing each T-Pass is $67 per month.

Finally, seven percent is spent on MIT's shuttle system, as well as an additional category called "commuting alternatives," which include a contribution to an private shuttle serving North Station and Cambridge called EZRide, carpools, vanpools, Zipcar car-share spaces, an emergency ride home policy, and bike racks. The breakdown of the budget is summarized in the following table.



3.1 Parking

MIT is bound by the City of Cambridge's implementation of the U.S. EPA Clean Air Act regulations for the Boston region, which both require a minimum amount of parking provided to avoid excessive pressure on resident and street parking, as well as encourage a limit on the number of parking spaces MIT is allowed to maintain on its campus to mitigate the environmental impact of driving. This limit is based on the number of students and square footage of the university's campus. To avoid the imposition of a hard cap on parking from the City, MIT implemented a voluntary cap at 4,814 spaces, the number of spots that existed when the voluntary cap was adopted. MIT can request the City's approval to add new parking spaces, but it would require that MIT submit a Parking and Transportation Demand Management plan, most likely for the entire campus. MIT would have to enter into negotiations with the City of Cambridge, much like any other developer wanting to justify large amounts of parking.

MIT has an unofficial stance that its 4,814 parking space allocation "is an asset," a benefit to its existing employees and part of an attractive package to offer potential employees. Any past suggestion of dropping below that amount has been disregarded. In fact, in 2005, MIT briefly sought an increase to 5,043. Upon not hearing back from the city of Cambridge on the matter, MIT decided not to pursue it further "until they really need them."

Both as a way to soften their voluntary cap and in order to maintain its 4,814 space allotment given parking lot closures to renovate and make room for new construction, MIT has leased up to 576 parking spaces at a given time. These spaces are leased at an average cost of $235/month[3]. 260 of these spaces are under contract due to the Broad Institute lease, but the rest can be cancelled at any time. However, it is important to note that these leased spaces bring the total number above 4,814, and the non-leased parking spaces have fallen below 4,814 due to construction. At the time of this report only 4,698 parking spaces are available.

3.1.1 Supply and Usage

Of the 4,814 parking spaces available under the parking cap, the number of spaces allotted to students and non-students are capped as well. A total of 1,103 spaces may be used by students while 3,711 spaces are set aside for professors, staff, and other non-student members of the MIT community.

Of those 3,711 parking spaces allocated to non-students, the table below provides information on how regular and occasional commuter parking permits are allocated amongst the various parking lots on and around campus as well as the utilization rate for each lot. Since some of the lots are primarily used by students the utilization rate by non-student commuters is very low at some locations.

[3] According to Dunham and Brown, the cost of leases went up from $548,000 to $1.3M as leased spaces went from 356 to 576.

Additionally, the current policy is to issue more parking permits than spaces in a given lot as not every commuter drives every day and passes are valid for use at more than just one lot.

Regular Commuter Usage by Location

Location	Total Number of Parking Spaces	Parking Permits Allocated to Regular and Occasional Commuters	Parking Spaces Used on Typical Day
Amherst Street	97	2	2
Eastgate Residents	94	1	1
Hayward Lot	212	149	138
Kresge Lot	94	56	51
Main Lot	97	77	72
North Area	739	655	586
Northeast Area	910	1007	916
Northwest Area	211	47	19
NW12 Lot	25	28	24
Off Campus-1 Kendall	7	7	3
Off Campus-1 Memorial Dr	100	99	91
Off Campus-185 Albany	30	30	29
Off Campus-320 Charles	86	67	63
Off Campus-3CC	25	24	22
Off Campus-E48	24	13	12
Off Campus-E70	23	20	20
Off-Campus-7CC	380	372	302
Off-Campus-Draper Labs	24	24	10
Off-Campus-Tech Square	130	127	112
Plasma Fusion	26	16	15
Riverside Area	302	238	176
Sloan Lot	60	60	58
West Garage	584	920	519
Westgate Lot	227	1	1
Total	4507	*4040*	*3242*

3.1.1.1 Construction plans

Vassar Street Improvements: The City of Cambridge has broken ground on a streetscape improvement plan for Vassar Street west of Massachusetts Ave. The project includes plans for repaving the street, improving pedestrian and bicycle facilities, and landscaping. The on-street parking spots along Vassar west of Massachusetts Ave., which were previously free with no time limits aside from a monthly street cleaning operation, have been removed and will eventually be replaced by approximately 100 metered parking spots[4].

West Garage: MIT will be rehabilitating the West Garage starting in the summer of 2007. The West Garage will remain open during construction, but approximately 25 percent of the 584 spaces will be unavailable at any given time.

[4] Estimated based on 20-foot parking spaces over a 2,400 foot streetscape, accounting for driveways, fire hydrants, and other impediments.

Sloan Building: MIT has broken ground on its new building for the Sloan School of Management. This building will contain an underground parking garage consisting of 416 underground spaces in addition to 60 restored on-site spaces. The stated ballpark capital cost for parking alone is $43 million. The Sloan Building is slated for completion in 2010.

3.1.2 Pricing

Under the existing parking permit structure, members of the MIT community are eligible to buy yearly parking permits as well as occasional and daily parking permits. The table below outlines the various permit types currently available and the corresponding yearly cost.

Parking Cost by Permit Type

Permit Type	***Cost (Yearly)***
Yearly staff passes:	*$638*
Yearly student passes:	*$657*
Reserved: limited	*No extra charge*
Evening (Student/Staff):	*$30*
Daily Visitor Pass:	*$10 a day*
Occasional Pass (Student/Staff)	*$30*
Yearly University Vehicle Pass:	*$759*
Yearly Contractor Pass:	*$759*
Commercial Pay Upon Entry:	*$3/hour; $12 max a day*
Yearly Carpool	*$320*
Yearly Professor Emeritus (w/compensation)	*$638*
Yearly Professor Emeritus (no compensation)	*$110*
Yearly Motorcycles	*$100*

Under this existing pricing structure, parking spaces are not priced differentially based on location. The cost of a parking spot is the same across all the lots, but varies only by type of pass held by different users.

3.1.3 Cost to MIT

3.1.3.1 Direct Costs

In total the expense for parking is $11 million annually. This is comprised of $700,000 for supplies and materials, $1.3 million for leased parking, $2.7 million in interest, $2.1 million in depreciation, $2.5 million for institute space charges, $800,000 contract services, and $900,000 in other operating expenses.

Parking Expenses

Category	**Expenses**
Employee Parking	$10,500,000
Student Parking	$560,000

MIT has built several underground parking lots, with plans for at least one more at Sloan, at a cost of $100,000 to $120,000 per space (approximately $800 per month over 30 years at an interest rate of 8 percent). This compares to a cost of roughly $25,000 to $30,000 per above-ground garage space. Benefiting MIT in this regard is the fact that underground parking does not count against its floor-area ratio (FAR) limits, so these underground lots do not limit the space that can be utilized for other purposes above ground.

3.1.3.2 Land Use Opportunity Cost

The opportunity cost to MIT of using valuable land for parking is a complicated issue, and one that cannot be easily quantified.

MIT has a similarly sized campus as other urban universities have. Its central campus consists of about 154 acres while Boston College has 186 acres, Boston University has 133 acres, and University of California Berkeley has 178 acres for their core campuses. The high cost, both financially and politically, of obtaining new land in Cambridge makes unutilized or underutilized parcels of land extremely valuable to the institution. Not only is the purchase of new land costly, the cost of mitigating contamination in Cambridge soil can add greatly to the acquisition cost. In addition, the City of Cambridge appears to be sensitive to the encroachment of the university and the related less desirable externalities, such as increased congestion, on neighboring residential areas. Each new land purchase by MIT requires negotiations with the City.

As previously mentioned, as MIT continues to grow and build new buildings and centers to meet other demands, the strategy has been to build underground lots to replace lost parking on built up parcels. There is a balance that must be achieved here between meeting a reasonable demand for parking, satisfying the City's constraints, and the high cost of building underground parking. Additional demand management practices where feasible (and there are still many for whom it is feasible to take public transit), would be highly valuable in alleviating some of the pressure of the university to balance these needs and constraints.

It is hard to estimate the value of land on campus before it has been put to use by building a building or other semi-permanent use on it. In the meantime, before the parcels are utilized in this more permanent fashion, it is reasonable to have a low-maintenance, revenue producing placeholder for the undeveloped parcels. Surface parking lots have provided a low maintenance source of revenue while serving as placeholders on parcels. While parking is considered an important amenity to the MIT community, other amenities might be just as highly valued. Providing cheap, accessible parking has a negative impact on the environment by serving as an incentive to drive alone to campus, and the high subsidy (despite the minor revenue brought in) of parking spaces in general is costing the university a significant amount of money.

If demand management is successful, the conversion of existing surface lots, and even other above and below ground lots, should be weighed against the values of other amenities such as parks, sports fields, dormitories or other buildings in high demand, or facilities space required to run the campus.

3.1.4 Subsidy

Current revenue generated by parking is $3 million per year. Of this total, $2.4 million is generated by employees, $360,000 by students, $50,000 by violations and $223,000 from other sources.

Overall the annual average revenue per parking space is $642; however the annual average expense per space is $2,297 which results in an average subsidy by the university of 72 percent.

Broken down by user type, the expense for employee parking is $10.5 million and the revenue generated is $2.7 million. For student parking the expense is $560,000 while the revenue generated is $390,000.

Parking Subsidy Level

Category	Expenses	Revenues	Subsidy*	% Subsidy
Employee Parking	$10,500,000	$2,700,000	$7,800,000	74.29%
Student Parking	$560,000	$390,000	$170,000	30.36%

*from various sources, i.e. EB and GIB, respectively

3.1.5 On Street Spaces

Above and beyond the 4,814 spaces that MIT controls and maintains there are 604 on-street parking spaces within the campus that are administered by the City of Cambridge and by the Commonwealth of Massachusetts' Department of Conservation and Recreation (DCR).

The spaces administered by DCR are all on Memorial Drive, and as of May 2007 street cleaning will be in effect once per month on those spaces from April through October. These spaces are unmetered, and other than the new street cleaning there are no restrictions on their use.

The spaces administered by the City of Cambridge are all metered, with a two-hour limit between the hours of 8:00 a.m.-6:00 p.m. The charge is 25 cents for 30 minutes, and the meters are not enforced on Sundays. With the construction ongoing, particularly along Massachusetts Avenue, some of the meters in this inventory have been temporarily removed, but will be replaced upon completion of the construction. These include:

Administered by the city of Cambridge (472 spaces):

- 107 spaces on Mass. Ave. between Lafayette Square and Charles River
- 66 spaces on Main St. between Portland St. and Charles River
- 58 spaces on Albany St.
- 37 spaces on Portland St. btw Albany St. and Tech Square
- 33 spaces on Sidney St.
- 30 spaces on Ames St.
- 22 spaces on Vassar St., all east of Mass. Ave.; approximately 100 spaces will be added west of Mass. Ave. upon completion of streetscape improvements (see section 3.1.1.1)

- 22 spaces on Lansdowne St.
- 16 spaces on Pacific St.
- 16 spaces on Osborn St. north of Albany St.
- 15 spaces on Broadway between 3rd St. and Charles River
- 13 spaces on Wadsworth St.
- 13 spaces on Windsor St. between Mass. Ave. and State St.
- 7 spaces on Erie St. between Sidney St. and Albany St.
- 6 spaces on Green St.
- 6 spaces on Front St.
- 5 spaces on Amherst Street

Administered by DCR:

- 132 spaces on Memorial Drive, 91 of which are east of Mass Ave.: unmetered, street cleaning once per month

The non-MIT administered spaces are in prime locations on the MIT campus and are used by the MIT community. Because they are under-priced (or not priced at all) they undermine the official MIT parking policies. This is especially salient in light of the paucity of visitor parking in the area.

The spots on Massachusetts Avenue are currently used almost exclusively by contractors and employees of construction companies working at MIT. Most of the spaces on Memorial Drive are used by resident students and construction contractors who arrive early enough in the morning to claim these prime, free spaces.

3.1.6 Issues and Concerns

If the goal is to induce people to switch from driving alone to reach campus to taking transit, MIT's policy of charging an annual fee for parking while not allowing those same people to purchase a subsidized transit pass leads to perverse incentives. In effect, this policy requires that a cost minimizing person choose at a single point in time whether they will drive to campus each day or take transit. While the occasional parking permit solves some of these issues by imposing a daily rate on parking, the additional costs imposed by MIT for using the occasional permit on a frequent basis create a disincentive for those people who might prefer to take transit one or two days per week to switch from an annual permit to an occasional permit. A person who prefers to take transit when it is convenient is thus foregoing a parking space that is already paid for: their cost for that day is both the cost of the parking permit and the transit fare they are required to pay. The annual pass thus creates a situation wherein the marginal cost of driving to work is only the perceived cost of the gas used during the drive (it is generally accepted that people heavily discount the maintenance and other ownership costs of the drive), whereas the marginal cost of taking transit is the cash fare. Furthermore, the transit fare is paid on a per trip basis, whereas the cost of gas is likely paid on a weekly or even more infrequent basis, and thus is not necessarily directly perceived as part of the cost of the commute.

Parking has been historically viewed as a key amenity at MIT. Our sense from various interviews is that parking is often viewed as a right despite MIT's highly accessible urban location, and is an important negotiation piece in the hiring of the valuable staff. This amenity, considering its costs to MIT in subsidies and use of valuable land, should not necessarily be eliminated, but should at least be fairly priced to reflect the high value of the land it uses. There is, of course, some political risk of increasing prices of parking, but there is also serious risk, financially and politically, of continuing to favor it as a prioritized right rather than an amenity in the same class as many other amenities, or even less prioritized because of the considerable negative externalities associated with it.

The highest drive alone mode share is associated with faculty members, who have an interest in keeping the price of parking as low possible. However, there is the mitigating factor of their usual desire to park as close to their offices as possible. Their standing within the MIT community may create some complications when increasing the price of parking, inasmuch as they may use their standing to oppose any changes to current parking policy. Thus, any parking policy must consider their interests. An increase in price should also be accompanied by a real change in the quality of service, such as guaranteeing faculty a spot in the lot of their choosing, should they be willing to pay a premium price.

The issue of equitable distribution of the price of parking is a strong motivator for any change in policy. Some employees made the choice to work at MIT before charges for parking were imposed. A commensurate pay raise has not necessarily accompanied this additional price. Simply increasing prices serves to decrease real wages. While parking prices are far below market rates in Cambridge, the across the board increase in parking prices of 11 percent per year that is expected to continue indefinitely as new underground parking is constructed outpaces inflation. While shifting residences to a more transit advantaged area may decrease the cost of their daily commute, this is hardly expected to take place in the short run, and is unlikely for existing employees in the long run. While we are committed to decreasing demand for parking at MIT, this demand shift cannot come at the cost of an imposed longer commute for existing employees. It would be desirable to encourage existing employees to shift modes while giving them the option to continue driving without increasing their costs. Differential pricing of lots may help us serve this objective, inasmuch as it provides a lower cost option for those who choose not to switch modes, but do not mind giving up a little convenience.

Lastly, the non-differentiated costs for lots—despite variable demand—results in lots, such as the West Lot, that are nearly empty on a daily basis, whereas centrally located underground structures such as Stata are in high demand. Because spaces are allocated centrally rather than priced to create even demand, people who park in Stata pay the same price as those who park in the West Lot, despite the extreme difference in the utility of those two parking options. Furthermore, this creates a situation wherein the most convenient spaces on campus can not be allocated to people visiting MIT. The MIT community has an interest in seeing that its visitors are able to arrive at their appointments in a convenient fashion. Any parking policy should take visitor demand into account, and ensure that the most desirable lots are accessible, at a cost, to all comers.

3.2 Transit

3.2.1 Current Practice

MIT is advantageously located, with access to the MBTA Red Line at the Kendall Square and Central Square stations and the #1 and #CT1 buses running on Massachusetts and stopping at three locations on campus. MIT is also served on East Campus by the #64 and #68 and #85 buses, and by the #CT2, which runs along Vassar Street. MIT is also accessible by both commuter rail stations in Boston, with access to North Station via the MIT-subsidized EZRide Shuttle and to South Station via the Red Line.

MIT currently subsidizes MBTA passes for both qualified employees (those who qualify for benefits: are paid for at least half-time employment) and students at an average rate of 46 percent. Employees and students must enroll online. For bus and subway services, there is a one-time procedure wherein the recipient is required to pick up their CharlieCard, after which their pass is renewed on a monthly basis if they do not intervene to halt or cancel service. Commuter Rail pass recipients are required to pick up their pass at the parking office each month, at least until the Commuter Rail system is able to accept CharlieCards.

3.2.2 Supply and Usage

Based on the 2006 MIT Transportation survey, as well as information obtained from the Central Transportation Planning Staff (CTPS), the following is an inventory of MBTA services on MIT's campus, with estimated daily MIT boardings:

MIT's Accessible MBTA Services

Route	Origin-Destination	Daily Round Trips	Route Cycle	Headway	Cost	Estimated Daily MIT Boardings
Red Line	Alewife-Braintree & Ashmont via Kendall and Central Squares	203	37-48m	4-7m	$1.70	4,500
#1	Harvard Sq.-Dudley Sq.	112	25-42m	Peak: 7m Off-Peak: 20m	$1.25	1,000
#CT1	Boston Medical Center-Central Sq.	34	20-27m	Peak: 20m Off-Peak: 30m	$1.25	180
#CT2	Sullivan Sq./Ruggles	31	38-50m	Peak: 15m Off-Peak: 30m	$1.25	230
#64	Oak Sq.-Kendall Sq.	38	24-39m	Peak: 20m Off-Peak: 1h	$1.25	85
#68	Harvard Sq.-Kendall Sq.	25	12m	30m	$1.25	70
#70/	Cedarwood, N. Waltham,	72	33-	Peak: 10m	$1.25	140

70A	or Watertown Sq.-University Park		67m	Off-Peak: 55m		
#85	Spring Hill-Kendall Sq.	22	10-14m	Peak: 25m Off-Peak: 40m	$1.25	130

Because the MIT subsidized MBTA pass program is an "opt-in" program by design, there is a wide disparity in participation by different segments of the MIT population. Not surprisingly, students who live off campus use the program more than those who live on campus. The following chart shows the number of passes distributed to each type of passholder, excluding employees who work on locations off the main campus, including Lincoln Labs. It is clear that those who work outside of the main campus purchase T Passes at a much lower rate than those who work on the main campus

Passholders by recipient status*

	Non Passholder	Bus Passholder	LinkPass Passholder	Commuter Passholder	Total
Undergraduate student (lives off campus)	816	99	78	1	994
Undergrad (lives on campus)	3,036	24	118	2	3,180
Graduate student (lives off campus)	2,418	155	1,363	67	4,003
Graduate student (lives on campus)	1,777	29	253	7	2,066
Other student	31	0	5	0	36
Faculty	863	3	101	27	994
Other academic staff	804	44	426	37	1,311
Administrative staff	1,191	39	436	187	1,853
Support staff	749	62	547	120	1,478
Service staff	641	22	154	23	840
Sponsored research staff	815	32	393	135	1,375
Medical staff	84	1	18	3	106
Unknown	12	0	0	0	12
Total	13,237	510	3,892	609	18,248

* Only includes students and employees who are eligible for benefits and work on the main campus.

Based on the Transportation Survey administered in October of 2006, it is possible to estimate how often these groups actually use MBTA services. As expected, this chart shows that passholders use services more than non-passholders, and off-campus students use the MBTA more than on-campus students. People who hold a LinkPass or a Commuter Rail Pass take on average 5 round trips per week. We can also see that those people commute to work by means other than the T or driving take transit on average approximately 1.5 round trips per week, while even those people who drive to work on a regular basis take 2-3 round trips per month.

MBTA usage by type of pass held and status (one-way trips/week)

Type		Comm. Rail + Subway	Comm. Rail	Subway	Bus + Subway	Expr. Bus	Local Bus	Total trips
Passholder (not from MIT)	**Total**	**0.82**	**0.21**	**4.18**	**1.93**	**0.02**	**1.39**	**8.56**
	Staff	0.96	0.19	4.70	2.96	0.00	1.04	9.85
	Student	0.71	0.24	3.76	1.12	0.03	1.68	7.53
	Undergrad	1.17	0.33	4.00	0.17	0.00	1.00	6.67
	Grad	0.61	0.21	3.71	1.32	0.04	1.82	7.71
	Undergrad (off campus)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Undergrad (on campus)	1.17	0.33	4.00	0.17	0.00	1.00	6.67
	Grad (off campus)	0.68	0.16	3.88	1.32	0.04	1.84	7.92
	Grad (on campus)	0.00	0.67	2.33	1.33	0.00	1.67	6.00
Non Passholder	**Total**	**0.07**	**0.04**	**1.78**	**0.23**	**0.03**	**0.62**	**2.77**
	Staff	0.09	0.06	1.71	0.29	0.03	0.39	2.57
	Student	0.06	0.03	1.79	0.22	0.03	0.67	2.81
	Undergrad	0.07	0.03	1.49	0.22	0.03	0.76	2.59
	Grad	0.05	0.04	2.10	0.22	0.04	0.57	3.02
	Undergrad (off campus)	0.05	0.01	1.55	0.24	0.04	1.12	3.01
	Undergrad (on campus)	0.08	0.03	1.47	0.21	0.02	0.66	2.47
	Grad (off campus)	0.04	0.04	2.27	0.20	0.04	0.56	3.15
	Grad (on campus)	0.07	0.04	1.83	0.24	0.03	0.58	2.80
Bus Passholder	**Total**	**0.01**	**0.02**	**1.41**	**0.72**	**0.28**	**5.95**	**8.39**
	Staff	0.02	0.00	1.40	0.79	0.30	6.79	9.31
	Student	0.01	0.04	1.42	0.67	0.26	5.39	7.79
	Undergrad	0.01	0.02	1.13	0.64	0.36	5.26	7.41
	Grad	0.01	0.04	1.61	0.69	0.19	5.49	8.03
	Undergrad (off campus)	0.01	0.03	1.11	0.63	0.42	5.70	7.90
	Undergrad (on campus)	0.00	0.00	1.20	0.68	0.11	3.40	5.39
	Grad (off campus)	0.01	0.05	1.61	0.52	0.21	5.95	8.34
	Grad (on campus)	0.00	0.00	1.66	1.62	0.10	2.99	6.37
LinkPass Passholder	**Total**	**0.07**	**0.03**	**6.80**	**1.81**	**0.11**	**1.32**	**10.13**
	Staff	0.05	0.03	6.28	2.51	0.12	1.47	10.45
	Student	0.10	0.02	7.39	1.02	0.09	1.14	9.77
	Undergrad	0.19	0.08	4.40	1.34	0.20	1.86	8.07
	Grad	0.09	0.02	7.72	0.98	0.08	1.06	9.94
	Undergrad (off campus)	0.00	0.00	5.32	1.75	0.21	2.55	9.82
	Undergrad (on campus)	0.32	0.12	3.79	1.07	0.20	1.40	6.90
	Grad (off campus)	0.10	0.02	8.45	1.00	0.08	1.06	10.70
	Grad (on campus)	0.07	0.02	3.77	0.84	0.07	1.05	5.81
Commuter Rail Passholder	**Total**	**5.11**	**1.80**	**2.04**	**0.50**	**0.08**	**0.33**	**9.86**
	Staff	5.37	1.91	1.94	0.52	0.09	0.31	10.14
	Student	3.31	1.06	2.72	0.36	0.08	0.42	7.94
	Undergrad	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Grad	3.44	1.11	2.83	0.37	0.08	0.43	8.26
	Undergrad (off campus)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Undergrad (on campus)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Grad (off campus)	3.80	1.22	2.89	0.39	0.09	0.48	8.86
	Grad (on campus)	0.00	0.00	2.25	0.25	0.00	0.00	2.50

Type		Comm. Rail + Subway	Comm. Rail	Subway	Bus + Subway	Expr. Bus	Local Bus	Total trips
Occasional Parker (no T Pass)	**Total**	**0.07**	**0.05**	**0.96**	**0.14**	**0.01**	**0.20**	**1.44**
	Staff	0.08	0.06	0.98	0.12	0.01	0.18	1.43
	Student	0.00	0.00	0.72	0.34	0.09	0.38	1.53
	Undergrad	0.00	0.00	1.00	0.00	0.00	2.00	3.00
	Grad	0.00	0.00	0.71	0.27	0.09	0.27	1.33
	Undergrad (off campus)	0.00	0.00	1.00	0.00	0.00	2.00	3.00
	Undergrad (on campus)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Grad (off campus)	0.00	0.00	0.73	0.27	0.09	0.27	1.36
	Grad (on campus)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Regular Parking Permit Holder	**Total**	**0.05**	**0.02**	**0.81**	**0.12**	**0.01**	**0.13**	**1.14**
	Staff	0.05	0.03	0.64	0.11	0.01	0.11	0.95
	Student	0.05	0.01	1.69	0.16	0.02	0.26	2.19
	Undergrad	0.00	0.00	1.32	0.05	0.03	0.34	1.74
	Grad	0.05	0.01	1.73	0.18	0.02	0.25	2.24
	Undergrad (off campus)	0.00	0.00	1.30	0.20	0.10	0.60	2.20
	Undergrad (on campus)	0.00	0.00	1.32	0.00	0.00	0.25	1.57
	Grad (off campus)	0.09	0.03	1.46	0.10	0.00	0.27	1.96
	Grad (on campus)	0.04	0.00	1.81	0.20	0.03	0.25	2.33

3.2.3 Pricing, Cost and Subsidy

MBTA Fares, Parking Prices and MIT Subsidy by Type of Pass (per month)

Type of Monthly Pass	Full Cost	Employee Cost	MIT subsidy
Bus	$40.00	$15.50	$24.50
LinkPass	$59.00	$29.50	$29.50
Commuter Rail Zone 1	$135.00	$67.50	$67.50
Commuter Rail Zone 2	$151.00	$79.00	$72.00
Commuter Rail Zone 3	$163.00	$91.00	$72.00
Commuter Rail Zone 4	$186.00	$114.00	$72.00
Commuter Rail Zone 5	$210.00	$138.00	$72.00
Commuter Rail Zone 6	$223.00	$151.00	$72.00
Commuter Rail Zone 7	$235.00	$163.00	$72.00
Commuter Rail Zone 8	$250.00	$178.00	$72.00
Average Parking	$191.45	$53.48	$137.97
Leased / Above Ground Parking	$183-235	$53.48	$130-182
Underground Parking	$733-917	$53.48	$720-864

MIT's stated policy is to strive for a 50 percent subsidy of MBTA services. With the recent MBTA fare increases the subsidy is slightly less than the stated amount, though $222,000 is being added to the FY08 parking and transportation budget to return the MBTA subsidy to 50 percent. Prior to moving to CharlieCards MIT benefited from the approximately 11 percent discount available from the MBTA for students through the purchase of semester passes. That program is not currently operational, and thus MIT is subsidizing an additional 11 percent of student costs as of May 2007 than it was in December of 2006. The table below reflects the current subsidy.

MIT Transit Pass Subsidies*

		All	Employees	Students
Commuter Rail	MIT Subsidy	$500,918	$444,435	$56,483
	Recipient Contribution	$867,200	$782,035	$85,165
	Recipients	610	533	77
	Subsidy %	36.61%	36.24%	39.88%
All Other	MIT subsidy	$1,413,358	$772,560	$640,798
	Recipient Contribution	$1,361,496	$751,282	$610,214
	Recipients	4402	2283	2119
	Subsidy %	50.93%	50.70%	51.22%
Total	MIT Subsidy	$1,914,276	$1,216,995	$697,281
	Recipient Contribution	$2,228,696	$1,533,317	$695,379
	Recipients	5012	2816	2196
	Subsidy %	46.21%	44.25%	50.07%

*As of November 2006. Annualized costs based on scaled numbers from November 2006 to annual basis. See Appendix 2 for more detail on methodology

3.2.4 Issues and Concerns

"Occasional" usage of the MBTA by non-passholders is much higher than expected. While the approximately 25 percent of the population who purchase passes through MIT spend about $4 million per year on transit including the MIT subsidy, the 75 percent who do not purchase transit passes from MIT spend approximately $3 million per year. Furthermore, this usage is not distributed equally among users: walkers and bikers spend more per month on MBTA service than people who have a parking permit. If this cost is passed on in the form of a transportation fee it may not be apparent to users that their occasional usage is so large, and thus there may some political push back even from people who, on net, benefit economically from our proposals.

While the commuter rail benefit is clearly a net attractor for the MIT community in terms of the benefits it provides employees (and a small percentage of graduate students) the net energy and environmental impacts of this subsidy are not easy to determine. On the one hand, it encourages those people who have the highest drive alone mode share to stop driving to work. For those people who have already made the choice of where to live, then, the benefits are clear. However, inasmuch as the subsidy will affect the residential location choice of current and future employees, it may have a negative environmental impact. If more employees are able to locate further from the MIT campus because of the subsidy, even if their commute-to-work drive alone mode share is decreased, they may have moved from an area where it is less necessary to own and use a car (or second car) to one where their non home-to-work journeys require the use of a car. If this effect is real, the short run effect of the commuter rail subsidy is a net positive in its environmental impact, whereas the long-term effect is a net negative. While this long-term effect may be small at the current commuter rail subsidy level, at increased subsidy levels these long-term location choices may outweigh the short-term reduced usage by existing employees.

3.3 Shuttles

Aside from MBTA bus routes, MIT has eight shuttles that navigate through various parts of campus. Six of these shuttles are directly owned and operated by MIT, with an estimated daily usage of 1,000 to 1,200, primarily on the Tech and NW Routes:

MIT Shuttle Operations

	Hours of Operation	Daily Round Trips	Route Cycle	# of Buses	Headway	FY 06 Riders
Tech Shuttle	7:15 a.m.-7:15 p.m.	42	17m	2	Peak: 10m Off-Peak: 20m	177,000
NW Shuttle	7:25 a.m.-6:45 p.m.	40	17m	2	Peak: 10m Off-Peak: 20m	86,000
Saferide	6:00 p.m.-3:30 a.m.	19	25m	1	30m	247,000
Boston Daytime	8:00 a.m.-6:00 p.m.	30	16m	1	20m	53,000
Lincoln Labs	7:00 a.m.-7:00 p.m.	6	40m	1	2h	
Wellesley	7:00 a.m.-2:00 a.m.	15	~50m	1	~1h	

In addition, two other shuttles are operated independently, though are accessible to members of the MIT community:

MIT Accessible Shuttles

Operator	Origin-Destination	Daily Round Trips	Route Cycle	Headway	Cost	Estimated Daily MIT Boardings
M2 Shuttle: MASCO	LMA-Harvard via Mass. Ave.	54	25m	Peak: 5m Off-Peak: 1h	$2:30	<100
EZRide: Charles River TMA	North Station-Cambridgeport via Kendall Sq. and University Park	47	12-15m	Peak: 10m Off-Peak: 20m	Free	300

The six that are directly paid for by MIT operate at an annual cost of roughly $1 million, with $145,000 coming from the Division of Student Life (DSL), donors, and charters. This leaves $855,000 to be jointly subsidized by the General Institute Benefit (GIB) and Employee Benefit (EB) pools at a subsidy level of 85 percent. Saferide and Boston are funded entirely from GIB, while Tech and NW are split between GIB and EB. EZRide is free to MIT students and employees based on a $98,000 annual contribution to the operator.

Shuttle Costs and Revenue

Cost

Maintenance & Repairs	$164K
Drivers (contract services)	$680K
Fuel	$110K
Vehicle Leases	$70K
Total	$1,024K

Revenue

Division of Student Life & Donors	$75K
Charters	$70K
Total	$145K

MIT used to own all the shuttles, but it has proved difficult to obtain funds to buy new shuttles. MIT is now beginning to lease the vehicles in its transition to larger vehicles to meet increasing demand. Currently, MIT is leasing two 40-foot buses, with one being used on the Tech Route and one on the NW Route. In the near future, MIT will be leasing four additional large buses.

MIT shuttles get 6.26 miles per gallon of gas to move 562,000 users per year. MIT is installing its own biodiesel fuel station soon and is working on converting its vehicle stock to diesel engines.

Shuttle Costs, Revenue and Ridership

Average

Cost/rider	$1.80
Hours	21,304
Cost/hour	$47.38
Miles	194,069
Cost/mile	$5
Gallons	31,002

July 2006 to January 2007

	Cost/hour	**Riders**
Tech	$45	103,458
NW	$47	47,043
Saferide	$53	152,345
Boston Daytime	$51	30,830

3.3.1 Issues and Concerns

According to the MIT Parking and Transportation office, the main issue with the shuttles is overcrowding. The shuttles are already at capacity, and bad weather exacerbates this issue in the winter. The Tech Shuttle provides the best coverage of parking lots, though these shuttles are mostly full. Additionally, the MBTA routes are unreliable. While the M2 Shuttle has capacity and could prove to be an alternative to the MBTA #1 bus route, MIT doesn’t contribute to its operation, and hence the cost to the MIT community is high at $2.30 per trip.

3.4 Sources of Funding

3.4.1 Federal & State Transportation Income Tax Benefits

MIT employees qualify for federal benefits for both parking and public transit. Employees can pay for MBTA services and parking with pre-tax earnings, up to a maximum of $105 per mode (per state law) each month. This saves federal, state, and FICA taxes for the employee and FICA taxes for MIT on the qualifying amount. Depending on the employee’s tax bracket, this may be a savings of approximately 33 percent per month. Because parking costs are significantly higher than transit costs on a monthly basis (except for commuter rail users), in real dollar terms monthly costs are reduced more for those who park than those who take transit by the Federal Transportation Benefits program.

3.4.1.1 Issues and Concerns

As a result of these Federal and State income tax benefits for employees, an increase in the rate of subsidy by MIT is undercut in its total benefit by the transfer of the cost from the employee to the employer. In effect, any additional dollar that MIT subsidizes reduces the total cost of the program (that is, the combined cost to MIT and their employees) by only approximately $0.67. This can also work as a benefit, in that if MIT reduces their subsidy by $1, they are only increasing the cost to an employee by approximately $0.67.

3.4.2 Benefits Pool

Parking and transit subsidies for employees are drawn from the employee benefits pool. More than 50 percent of the benefits pool for all employees at MIT is paid by the various sponsors of research at MIT through reimbursement of overhead charges.

3.4.2.1 Issues and Concerns

The employee benefits pool is an automatic source of funding for any proposed change in subsidy level for employees. However, there is no commensurate mechanism for students. Because many of the graduate students at MIT are sponsored by Research Assistant posts, there may be an opportunity to increase the cost of sponsoring a Research Assistantship to include full or partial subsidy of their transportation pass.

4 Alternatives

In this section we discuss the alternatives that we have analyzed in order to meet the objectives laid out in Section1, Introduction. This list is not exhaustive, nor do we recommend the immediate implementation of all items discussed here. The alternatives include, for Parking (1) Differential Pricing by Lot, (2) Differential Pricing by Lot with Reserved Parking, (3), Rate Increases with Use and (4) Additional Alternatives. For Transit this includes (1) An increase in subsidy levels (2) A Universal Pass (3) Installation of CharlieCard equipment and (4) Targeted Subsidies. For shuttles, (1) Leasing Structures, (2) The Feasibility of a Relationship with MASCO and its M2 Shuttle, (3) Scheduling and Capacity Enhancements, (4) Charter Services, and (5) Potential MBTA Re-routing Schemes are analyzed.

Each alternative is proposed, followed by a brief section outlining the projected impacts of the proposal. As in previous sections, proposals have been split into those that concern parking, those that concern transit, and those impacting shuttles. Those proposals that cut across these divisions are analyzed instead in Section 5.

4.1 Parking

In each of the proposed alternatives, parking permits would no longer be lot specific. Instead of annual rates, parkers would pay a daily rate plus a yearly general parking fee (which would provide them with a parking permit and help cover administrative costs).

Annual parking permits would only be available to certain types of users for whom it is more logical to provide yearly passes. These would be the following: students and staff who reside on campus, professors emeritus, carpools, and motorcycles.

4.1.1 Differential Pricing by Lot

We propose a change from a single yearly charge for most commuters to a charge for each day of parking. The daily fee would be differentiated by lot, based on location. The lots most in demand would be priced at the highest rate while the least popular lots would be priced in the lowest range. Demand for lots is a function of location as people tend to want to park as close as possible to their office or dorm. Those lots that are centrally located—like Sloan and Stata—are very desirable while the lots farther away from central campus—like Westgate—are less popular due to their distance from the concentrated areas of offices. The range of parking rates allows parkers to determine the value of location and convenience. Those who cannot afford an increased rate to park in the highest demand lots would still have a similar or even lower cost option. This would limit the inconvenience to captive and/or frugal drivers to perhaps a longer walk to their dorm or office, which can be mitigated through an improved shuttle system and the Vassar Street streetscape improvements. In this and the following options we propose removing any charges for parking on weekends, outside of those for special events.

4.1.1.2 Identification of Lots by Price Level

Based on the demand calculations provided by the Parking and Transportation Office, each campus lot was classified into one of four categories: student, low price, medium price, and premium price. Certain lots were reserved only for students and staff residing on campus (1) to simplify the administration process as resident students would still be on annual permits rather than on a daily rate and (2) because they primarily park near the dormitories on west campus. Low priced lots were identified as surface parking lots that are located furthest away from central campus. Premium lots were identified as centrally located garages and the remaining high use, surface parking lots as well as the West Garage were identified as medium priced lots.

The following table shows the classification of each lot on campus with zone 1 representing premium lots, zone 2 representing medium lots, zone 3 representing low priced lots and zone 4 representing student lots. These designations are not fixed, they are merely suggestions and the designation could easily be adjusted based on experience and changing demand. Additionally, any resident student lots that are not full (zone 4 below) could also serve as a lot for commuters, with its zone depending on its location.

Price Level of Campus Lots

Parking Area	Parking Facility Name	Spaces	Price Zone
Amherst	Amherst & Danforth	51	4
Amherst	Dormitories	46	4
Cruiser Lot	Cruiser Lot	4	2
East Campus	East Campus	5	2
Ford	Ford Lot	22	2
Hayward Garage Lot	Hayward Garage Lot	50	4
Hayward Street	Hayward Street Lot	212	2
Kendall Square	Kendall Square Lot	52	2
Kresge	Kresge Lot	94	2
Main	Main Lot	97	2
North	Albany Garage	432	2
North	Windsor Street lot	76	2
North	N10 Lot	170	2
North	158 Mass Avenue	50	2
North	Cross Street	11	4
Northeast	Stata Garage	679	1
Northeast	East Lots	28	2
Northeast	East Lot	203	2
Northwest	NW86 Lot	72	4
Northwest	NW86 Garage	139	4
Northwest	65 Waverly	72	3
NW16	Nuclear Reactor Lot	25	2
Broad	Broad-320 Charles	86	3
Off Campus	1 Kendall	7	2
Off Campus	3 Cambridge Center	25	2
Off Campus	7 Cambridge Center	380	1
Off Campus	Tech Square	130	2
Off Campus	Draper	24	2
Off Campus	53 Wadsworth	24	2
Off Campus	1 Broadway	23	2
Off Campus	185 Albany	30	2
Off Campus	1 Memorial Drive	100	2
PSFC	Plasma Fusion Lot	26	2
President's House	President's House	8	2
Sloan	Hermann Garage	25	1
Sloan	E51 Lot	60	2
Sloan	Sloan Lot	44	4
Student Center	Student Center	3	2
Riverside	West Lot	160	3
Riverside	W91 Lot	57	3
Riverside	W92 Garage	64	2
Riverside	350 Brookline Street	21	3
West Garage	West Garage	490	3
West Garage	West Annex Lot	94	3
Westgate	Westgate lot	161	4
Westgate	Westgate Low Rise	66	4
Total Inventory		**4698**	

4.1.1.3 Total Allocation of Spaces by Lot Type

The following table provides information on the number of spaces within each zone and the percentage of total spaces that are allocated to each zone. As the breakdown shows, about half of the total parking spaces are in the medium price range with roughly equivalent amounts of low and premium priced spaces summed together (approximately a quarter of the total each). Student spaces account for the smallest percentage of total spaces.

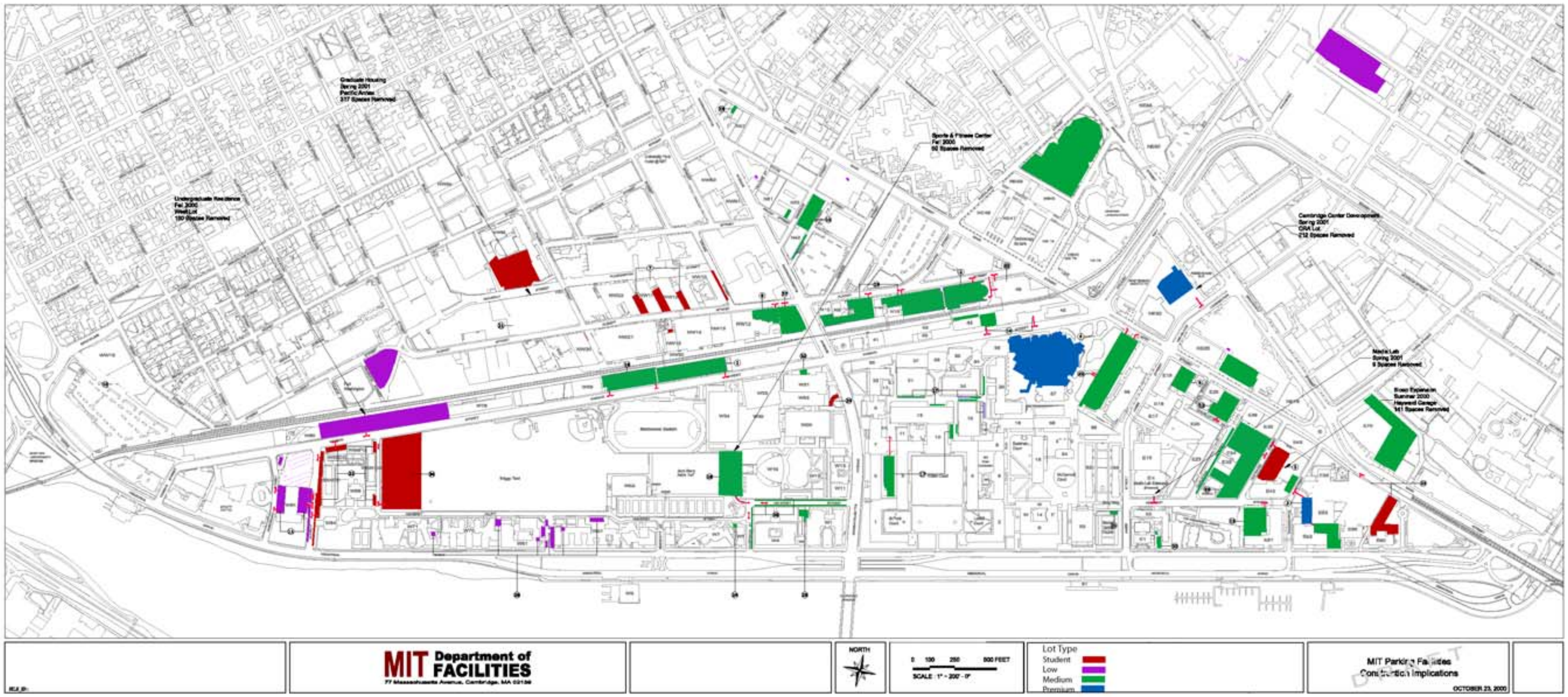
Lot Allocation by Zone

Price Zone	Number of Spaces	Percentage of Total	Percentage of Total (excluding student spaces)
4 – Student	640	14%	NA
3 – Low	1084	23%	27%
2 – Medium	1994	42%	49%
1 – Premium	980	21%	24%

4.1.1.4 Location of Lots on the MIT Campus

The following map shows where each lot is located on the MIT campus and each lot is color coded to reflect the price zone that it is in. The red represents student lots, purple is Price Zone 3, green is Price Zone 2 and blue is Price Zone 1 or premium lots.

Looking at the map, one can see that the student lots are concentrated in the west where the majority of student housing is located and also in the least popular area for commuter parking as it is the farthest away from central campus. Similarly, the lowest priced lots are located in this area with the exception of the Broad lot which is in the far northeast.



Cambridge Center Development
Spring 2001
CRA Lot
212 Spaces Removed
Media Lab
Spring 2001
MIT Department of FACILITIES
NORTH
0 100 250 500 FEET
SCALE 1" = 200' - 0"
Lot Type
Student
Low
Medium
Premium
MIT Parking Facilities
Construction Implications
OCTOBER 23, 2000

4.1.1.5 Proposed Differential Pricing Structure

The following table outlines three proposed differential pricing structures.

Differential Pricing Structure Options

	Tiers of Pricing	Zone 3	Zone 2	Zone 1
Option One	3	$2	$4	$6
Option Two	3	$2	$6	$10
Option Three	2	$2.25	$2.25	$7

In each of the three options the daily rate for zone 3, or low priced lots, was set around $2, which is lower than the average daily parking price of $2.77[5] that drivers are paying under the current annual pass system. In option three, over 75 percent of the parking is priced at $2.25, which is the average daily parking price if the planned 2007-2008 11 percent increase was implemented along with a proposed $15 per month Mobility Pass. Option three has also been designed so that MIT will not collect any more revenue than it would under the current system. (See Sections 2 and 5 for more details on the Mobility Pass itself).

By offering parking spaces that are priced close to what drivers are paying now, this helps to address equity concerns for those drivers who have no transit options but may not be able to afford a large increase in parking costs. Improved shuttle services to lower prices lots will further address equity concerns.

4.1.2 Differential Pricing by Lot with Reserved Parking

Similar to the first alternative, in this scenario there would be differential daily pricing by lot, but it would also include a number of reserved spots in premium locations (like the first floor or those nearest to the entrance of a building). The assigned user of the reserved spot would pay a premium above the general rate in order to ensure that they would be guaranteed the availability of a spot in a particular section of a lot that is most desirable. It would also be possible to restrict the hours that a space can be reserved (say until noon) so that unused spots can be re-allocated to visitors if the assigned user will not be on campus that day. This guarantee could be offered on an annual basis for the equivalent of $2 per day ($400 to $450 per year).

4.1.3 Greater Use, Greater Increase in Daily Rate

This alternative could be an addition to the Differential Pricing by Lot alternative or the Differential Pricing by Lot with Reserved Parking alternative. In this scenario the daily rate would depend not only on the lot, but also on the number of days a person has parked within a given month. For example, the first five days of parking would be charged at rate X, for the next five days the rate would be X + Y, and so on. This purpose of this would be to encourage drivers to use other means of transport for a portion of their trips.

[5] The current average daily parking price is based on 46 weeks of work, 5 days a week.

4.1.4 Other Parking Alternatives

4.1.4.1 Cash out Parking Subsidies

One alternative that has been implemented in many locations in California is the cashing out of parking subsidies. In these programs employers allow each of their employees to choose between continuing to receive subsidized parking and taking the value of that parking in cash.

While there are many different ways of implementing these programs, perhaps the simplest is to increase all employees' pay by the total cost of providing parking, and then remove all subsidies for parking. Since the cost of parking is no longer subsidized, employees who continue to park actually save money in this instance, as they save FICA, state and local taxes up to the amount they continue to spend on parking (up to the federal limits).

While this would be difficult to implement for students, MIT could allow employees the option of cashing out their parking benefit, and then charging an unsubsidized rate for parking, whether on an annual, monthly, or daily basis.

This will be a very expensive option, as the already relatively low single-occupancy vehicle (SOV) mode share for commuting to MIT means that the latent cost of providing parking to transit riders, walkers, and bikers becomes an actual cost. Although we have not estimated the mode shift that would result from this alternative, from experience elsewhere we can expect that it would be quite high.

If we assume that a parking cash-out decreases SOV mode share by 20 percent for employees, it is still an expensive option. We estimate that 8,005 employees would qualify for this cash out, and 2,582 would opt out and elect to continue paying the current rate for parking. This would leave 5,423 employees who would receive an additional payment of approximately $1,736 (the size of the average parking subsidy) per year, for a cost of an additional $9.4 million over the current cost to provide parking.

4.1.4.2 Seize Opportunities to Reduce Spaces When Garages Close

When above-ground lots close permanently to make room for new buildings, MIT should reconsider its position to always remain at its maximum parking cap, and instead use these lot closures as opportunities to drop below its cap. This would save significant money vis-à-vis the cost of replacing those spaces one-for-one with underground parking. For every underground parking space not built, the Institute saves roughly $100,000. Added to this amount is the interim cost of leasing off-campus spaces during construction at an average of $235 per month.

There is a fear that dropping below the cap would result in a permanent lowering of the number of parking spaces the university can provide. Combined with other demand management efforts and considering the high accessibility of the campus, a permanent change might be feasible, and even attractive because of the cost savings. While it may feel like a dangerous step to make, the university could phase this process by first reducing the number of spaces it leases, and then by reassessing demand after a differential pricing structure is put in place and before a new major construction project occurs.

4.1.4.3 Implement More Strict Student Parking Policies

Though the majority of MIT's parking is consumed by non-students, this is one particular constituency for whom the parking policies can easily be changed, especially given the fact that there is such a large turnover on a yearly basis.

These lots, if made available to the general MIT community, would provide additional spaces at the zone 3 rate comparable to the current cost of parking on campus, and would be complemented by improved shuttle services.

4.1.4.4 Take over administration of on street spaces from Cambridge and DCR

MIT could take over the pricing and enforcement of on-street parking from Cambridge and DCR, and redistribute the revenue (minus enforcement costs) to the appropriate jurisdictions. While this will not raise revenue for MIT, it will allow MIT to price these spaces so that they are available to visitors, rather than being used as long-term parking. If used for visitor parking or charged at a premium rate, these 132 spaces currently unmetered on Memorial Drive might be able to generate upwards of $1,320 per day or over $300,000 per year at a $10 daily rate. Administration costs would include the installation of meters or other equipment to collect revenues, and also increased enforcement.

4.2 Transit

4.2.1 Increase Subsidy level to 65 Percent for all MBTA services

Other benefits at MIT are currently subsidized at this level. This would entail no change to the current system, but we could expect that it may induce some additional "converts" to purchase a monthly transit pass through MIT. This would entail increasing the subsidy level for all categories of passes. The largest increases would go to commuter rail passholders, who currently pay the most and have the lowest subsidy level.

We estimate that with a transit price elasticity of -.2 (a two percent increase in riders for every 10 percent decrease in price), we would see an average of 26 daily drivers switch to taking the T or Commuter Rail. We may also expect to see some people who currently walk or bike to campus purchase a T pass, if their occasional usage is high enough. This comes at cost of almost $800,000 annually, more than 50 percent of which goes to the increased cost of providing a commuter rail subsidies, especially for those with longer journeys.

Cost for 65% subsidy

	All	Employees	Students
Bus Pass Subsidy	$149,823	$61,471	$88,352
Link Pass Subsidy	$1,653,832	$929,027	$724,805
Commuter Rail Subsidy	$889,277	$797,205	$92,072
Total MIT subsidy	**$2,692,931**	**$1,787,702**	**$905,229**

Current Costs

	All	Employees	Students
Bus Pass Subsidy	$141,179	$57,924	$83,255
Link Pass Subsidy	$1,272,178	$714,636	$557,543
Commuter Rail Subsidy	$500,918	$444,435	$56,483
Total MIT subsidy	**$1,914,276**	**$1,216,995**	**$697,281**

4.2.2 Create Universal "Mobility" Pass

A Universal Pass program would give all eligible employees and students an unlimited CharlieCard (and possibly a commuter rail pass). A rate would be negotiated with the MBTA based on expected usage by the entire group, and the costs spread to that group evenly, or subsidized by the administration. Because not all recipients will use the pass, the cost will be significantly lower than if all recipients simply purchased—or were required to purchase—a CharlieCard.

If MIT were to fully subsidize this program, it would mean that both commuting and non-commuting usage is paid for by MIT. If MIT were to distribute the costs to employees and students, there would likely be some opposition that would need to be overcome. This could be achieved by one of four methods:

1) Opt-out. This would allow any employee and/or student who did park on campus to opt out of the Universal Pass program. This would increase costs to all participants in the program, and/or remove the cost surety from the MIT subsidy level. Research on 401k accounts has shown that programs that require opt-out rather than opt-in to participate have significantly higher adoption rates. This program would require all students and employees to have a transit pass for the first three months they are on campus (a LinkPass subsidized 100 percent), and then allow them to opt-out of any future participation. This would have the effect of placing a CharlieCard in the hands of all new students and employees, while avoiding the costs and some of the political outcry we can expect from a required Universal Pass program that is not fully subsidized.

2) Do not include commuter rail in the Universal Pass program. This would significantly decrease the costs of the program per person, but would leave out the incentive for those most likely to be parking currently.

3) Phase the program in over a period of years. This would require all incoming students to participate over the course of their studies, but would not apply to current students. While it overcomes opposition by imposing costs on a student population that does not yet have a voice, it may be viewed as autocratic, and,

further, if the cost for those students is lower than that for current students who do purchase a CharlieCard, it may lead to charges of inequitable conduct on the part of the administration.

4) Charge different rates for different groups (employees, on-campus vs. off-campus students, graduates vs. undergraduates). Because the implementation mechanism will vary widely between these groups (payroll deduction vs. tuition increase or student life fees), this may be the most politically feasible method. It would allow, for example, employees to be completely subsidized, while students contribute through student life fees. It may also contain challenges of practicality of implementation.

4.2.2.1 Universal Pass for students and employees that includes commuter rail.

In this scenario, MIT could either cover the entire costs of the program, or provide an opt-out capability for all students and employees after an introductory period which would be fully subsidized by the administration. The “co-pay” associated with this program is at or below the “sweet spot” of $15 per month, which keep any current transit pass holders from paying an additional fee.

4.2.2.2 Universal Pass for students and employees that does not include commuter rail.

Administration and structure of this program would be the same as detailed above, except that only a LinkPass would be required. Commuter Rail would be an optional additional component at a 50 percent subsidy level.

A Universal Pass program that includes commuter rail will require an additional $3.3 million above and beyond the current MIT subsidy of $1.7 million and recipient contribution of $2.2 million. A large portion of this additional cost is based on the estimated $2.8 million annual usage of the MBTA by students and employees who do not purchase a T pass through MIT. If this were to be distributed to the entire campus without additional administration subsidy it would cost approximately $26 per month per person. If commuter rail is maintained at the current subsidy levels, and not included a Universal Pass program, the total cost would be approximately $1.2 million less per annum.

A Universal Pass program that allowed people to opt out, but charged all participants $15 per month to participate would cost approximately $1.3 million above the current MIT transit subsidy per year at a 50 percent commuter rail subsidy and $2.3 million above at a 100 percent commuter rail subsidy. We can expect that less than 11 percent of eligible participants will opt-out, as long as it is required to participate if one is to receive a parking permit.

See Appendix 3 for more details on the methodology behind these calculations.

Projected Universal Pass Costs and Revenue

		Current	Option A	Option B
	Monthly Cost to Participate	**$37.06**	**$15**	**$15**
	Commuter Rail Subsidy	**37%**	**100%**	**50%**
	Qualified Population	18,248	18,248	18,248
Opt Outs	Non Passholders	8,821	2,057	2,086
Opt Outs	Occasional Parkers (w no pass)*	513	35	36
Opt Outs	Regular Parkers	3,818	0	0
Opt Outs	Passholders not through MIT	85	0	0
	Total Participants	5,011	16,156	16,126
	Commuter Rail Passholders	609	16,156	609
	Covered LinkPass Usage by Participants	$2,544,357	$5,794,218	$5,342,327
+	Covered Bus Pass Usage by Participants	$230,497	$0	$0
+	Covered Comm. Rail and Exp. Bus Usage by Partic.	$1,368,118	$1,368,118	$1,368,118
=	**MIT Payment to MBTA**	**$4,142,972**	**$7,162,336**	**$6,710,445**
-	Participant Contribution for Bus Pass	$89,317	$0	$0
-	Participant Contribution for Link Pass	$1,272,178	$2,908,011	$2,902,636
-	Participant Contribution for Commuter Rail	$867,200	$0	$577,667
=	**MIT subsidy**	**$1,914,276**	**$4,254,325**	**$3,230,141**
	MIT Payment to MBTA	$4,142,972	$7,162,336	$6,710,445
+	Uncovered usage by participants	$255,478	$0	$451,564
+	Uncovered usage by non-participants	$2,786,798	$22,912	$23,239
=	**Total Fares to MBTA by MIT population**	**$7,185,247**	**$7,185,247**	**$7,185,247**
	Additional People with Pass	0	11,145	11,115

* Occasional Parkers are permitted to purchase a subsidized MBTA Pass. Those people here do not do so.

4.2.3 Install MBTA CharlieCard Equipment on Campus

We assume that part of the reason that usage is not higher on campus is that for occasional bus users the nearest place at which they can obtain a CharlieCard is at the Kendall Square Red Line station, which is a 10 plus minute walk from the main bus thoroughfare on Massachusetts Avenue. They can refill their CharlieCard either on the bus, which is inconvenient if there is a line waiting to get on the bus, or at the Kendall station. If it is easier to obtain and refill a CharlieCard on campus it is postulated that it will become more convenient to simply "hop on" to the bus. While we do not expect that this will increase usage at the same rate as the previous proposals, the costs are also significantly lower.

We can expect that this will increase usage of the #1 bus somewhat on campus. It is a short-term alternative to the other options proposed, and a good addition if it can be obtained at a low cost, but it is not a replacement for any of the alternatives proposed in this section, as its effects on behavior are expected to be minimal.

4.2.4 Targeted additional subsidy for parkers who switch to transit

This would target the desired behavior of "switching" from driving alone to taking transit to get to MIT by offering a full transit subsidy to only those people who currently hold a regular parking permit. These "switchers" would then be required to give up their parking permit, and their occasional usage would need to be monitored. Because this would directly contribute to the reduced need for parking, this program would be quite inexpensive, and may even provide a revenue benefit to MIT. However, it would open to charges of inequity by all other transit pass holders who are required to pay on average approximately half the cost of their MBTA passes.

A $100 per month subsidy to those willing to switch to public transit would mean that MIT can draw down its number of leased spots at a savings to the Institute of $135 per month per space[6]. This offer can apply at least until the number of non-contracted leased spaces drops to zero, and if there is enough demand for this transit subsidy, the Institute can then look into other opportunities to promote this encouraged mode shift. One might also use this proposal as a one-time introductory offer for new and returning employees and students who drive to campus on a daily basis.

4.2.5 Improve MIT/MBTA Relationship

In addition to any MIT/MBTA Universal Pass negotiations, there are several MBTA bus routes that are underutilized due to deficient scheduling and routing. Many of these bus routes skirt the MIT campus, but with some relatively simple changes the MIT community can be better served. The following suggestions should be examined in more depth as a follow-up to this report.

1) Combine MBTA Route 1 and Route CT1. The only area served by the CT1 that is not served by the Route 1 is the eastern part of the Boston Medical Center. If combined into one route, perhaps with a quick loop around the Medical Center, the MBTA can decrease headways and improve frequencies.

2) Re-route MBTA routes #64, #70/70A, and CT2 to better serve MIT's Campus.
    a. Rather than going from Central Square to Kendall Square via Prospect Street and Broadway, the Route 64 bus should turn right on Massachusetts Avenue and then left on Vassar Street on its way to Kendall.
    b. Route 70/70A has very frequent service comes very close to MIT, but terminates in the University Park area after passing through Central Square. Instead, the route could be restructured to terminate closer to MIT's campus, either along Vassar Street or at Kendall Square.
    c. Data shows that ridership on the CT2 is low along the section currently connecting Sullivan Square to Kendall Square via Union Square. By altering the route to serve East Cambridge, not only can the CT2 connect to the MBTA Green Line, but it can better serve MIT's off-campus lots beyond Main Street.

3) Increase Service on MBTA Routes #68 and #85.
    a. Route #68 connects Harvard Square to Kendall Square along Broadway, and helps to serve a large part of MIT's off-campus housing constituency. However, the 30-minute peak headway makes this an unreliable option on any regular basis.
    b. Route #85 clearly serves as a feeder to the Red Line and MIT at Kendall Square from such areas as Spring Hill and Union Square. Much like the

[6] $100/month transit subsidy compared to $235/month lease cost.

Route #68, this route serves much MIT off-campus housing, but at 30-40 minute peak headways is not a realistic option for most people.

Even before any progress is made on future phases of the Urban Ring circumferential transit system, a strategic “meeting of the minds” between MIT and the MBTA could lead to some relatively simple changes in the MBTA bus system that can improve service to MIT from places like Waltham and Watertown to the West, Boston to the South, and underserved parts of Somerville and Cambridge to the north and east.

4.3 Shuttles

The following proposals seek to improve operations on MIT’s shuttle system, as well as to capitalize on opportunities to improve relations with private shuttle carriers in Cambridge that serve MIT’s campus. If adopted, these alternatives will alleviate the persistent capacity issues, provide redundancies throughout the system, allow MIT to cease operations on extraneous routes, and experiment with new revenue sources.

4.3.1 Lease Bigger Buses

The primary cost of shuttles is the payment of shuttle drivers. This expense accounts for 66.4 percent of the total cost of operating the shuttles[7]. MIT used to own all of its shuttles, but it has increasingly turned to leasing vehicles, which is encouraging because it makes a change in policy more feasible. Also encouraging is that although MIT is currently operating mostly small vans that are at capacity, it recently leased two bigger buses, with four more on the way. The vehicle leases only account for 6.8 percent of total costs[8].

By leasing larger buses, MIT should be better able to accommodate increased ridership expected due to the expected shifts in parking locations for various members of the MIT community, reducing the equity concerns of locating less expensive lots on the periphery of campus. Larger buses will help to tackle the capacity issues on the MIT shuttle system, particularly during the winter months.

4.3.2 Allow Better MIT Access to M2 Shuttle

In Cambridge, the M2 essentially runs along the same route as the MBTA #1 bus, but our experiences lead us to believe that the M2 has excess capacity. Published schedules tell an interesting story, as the M2 runs about half the daily runs as the #1, though headways are as low as 5 minutes on the M2 during peak periods, while they run only as low as seven minutes on the #1[9].

Harvard currently contributes to the M2, much like MIT does to EZRide. Of the $1.6 million in annual costs to operate the M2, Harvard pays 85 percent of those costs, which is charged to each of various schools at Harvard based on usage. There are roughly 2,700 trips made per day on the M2.

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[7] $680K of $1024K
[8] $70K of $1024K
[9] 54 each direction on M2 weekday, 112 on #1.

Not all Harvard students have free access to the M2. Only students at "HMS, HSPH, HSDM, GSAS, DMS, HBS and FAS, as well as Harvard University officers and staff" can ride the bus for free, according to the MASCO website[10]. Everyone else must pay $2.30.

This is potentially problematic since MIT students generally do not have any business in the Longwood Medical Area and would presumably be using the M2 solely between Harvard Square and Back Bay. Regardless, an agreement between MIT and MASCO would potentially eliminate the need for MIT's Boston Daytime shuttle, would increase access to MIT members along Massachusetts Avenue, and may provide a commuting alternative for those with easy access from the west to Longwood via the MBTA Green Line.

Based on Harvard's contribution, MIT would likely have to contribute somewhere in the neighborhood of $500,000 to $700,000 per year in order to fully subsidize usage on the M2, though even a 50 percent subsidy that would be in line with other public transportation subsidies at MIT would lower the cost per ride to barely over $1.00 and would not cost MIT significantly more than the $145,000 spent to operate the Boston Daytime Shuttle currently.

The Boston Daytime Shuttle is the route that has the fewest riders by far, and also has many MBTA alternatives. If MIT can work out an agreement with MASCO, the M2 runs a similar route that can replace the Boston Daytime. In addition, the donor who fronts almost half of the cost of the Shuttle is graduating, so alternative funding or an additional subsidy would need to be sought to keep it in operation at the current frequency[11].

4.3.3 Increase Service on Tech Shuttle and Reduce Service on NW Shuttle

Currently the Tech and NW shuttles run with essentially the same frequency[12]. However, the Tech shuttle far better captures the parking lots, particularly on West Campus. Additionally, the Tech is already much closer to capacity than the NW[13].

In relation to the location of parking spaces, the Tech Shuttle captures most of the campus, including the lots in the Far West part of campus, all the way eastward to Main Street to capture the off-campus leased spaces. The only portion of campus not covered by the Tech Shuttle is Mass. Ave. north of Albany, and the dorms in NW campus, which have less than 500 of the 4800 plus parking spaces on campus. It would make logical sense that if any parking changes are phased in before additional large buses can be leased, then any large buses should be used on the Tech route and not on the NW route.

[10] http://www.masco.org/transit/ptsM2_FareInfo.htm
[11] The Division of Student Life and donors pay for $75K of $145K annual cost.
[12] 42 daily Tech shuttles, 40 daily NW shuttles. Each run on 17 minute route cycles with 10 minute peak headways and 20 minutes off-peak headways during operation between 7:00 a.m. and 7:00 p.m.
[13] 177,000 FY06 riders on Tech versus 86,000 on NW.

4.3.4 Expand Charter Services on Weekends

Many of the shuttles rest idle on the weekends, while many departments at MIT plan trips on weekends and have a need for charter services. In addition, these charter services can, and should be advertised to organizations outside of MIT as well.

The current $70,000 annual revenue can be increased, perhaps significantly, if MIT can market its charter services better. MIT already has a solid fleet of vans to operate its shuttle system, and the Institute is investing in larger vehicles. The cost of having to pay drivers to operate these charters may partially offset any potential revenue gains, but clearly this is an area that MIT should be looking into more carefully.

5 Analysis of Alternatives

Based on the alternatives presented in Section 4, we have analyzed four options for combining a Universal Pass program, which we have included in a our Mobility Pass, with differentially priced parking policies. The alternatives have been selected in order to weigh our objectives of decreasing SOV mode share within a sound financial framework, while not penalizing those people who chose to drive to work prior to the introduction of priced parking at MIT. There is a tradeoff in each of these alternatives between these goals: there is no silver bullet. We believe that all the choices presented below would represent an improvement in all of the “Three Es” over the long term, as compared to the status quo alternative of making no changes to either parking or transit policies. The following pages present our complete impact analysis of each alternative.

Alternatives 1a & 1b: Annual pass price increase of 11%, with a commuter rail subsidy of 50% or 100%

Option		**1a**	**1b**
Parking Fees	**Current**	**11% increase**	**11% increase**
Commuter Rail Subsidy		**50%**	**100%**
Current Drivers Switching to Transit		64	98
Current Drivers Switching to Carpool		13	13
Percent of current Drivers Switching		-2%	-3%
Parking Daily Revenue	$9,053	$9,995	$9,891
Annual Mobility Pass Cost		$180	$180
Off Campus Users Opt In		185	185
On Campus Users Opt Out		2,122	2,092
Total participants w T Pass	5,011	16,311	16,341
Mobility Pass Revenue	$1,361,496	$2,935,980	$2,941,380
Additional Revenue from Commuter Rail Users	$867,200	$577,667	$-
Additional Revenue from Off Campus Users	$61,937	$48,549	$33,300
Parking Revenue from Fees	$2,082,116	$2,298,919	$2,274,991
Parking Revenue from exempt and visitors	$696,362	$670,816	$670,816
Additional Revenue from occasional spots	$325,888	$325,888	$325,888
Total Parking Revenue	$3,104,366	$3,295,623	$3,271,695
Total Revenue	**$5,394,999**	**$6,857,819**	**$6,246,375**
Spots required	4,814	4,736	4,703
Total Annual cost to provide parking	$11,000,000	$10,822,864	$10,745,656
Payment to MBTA w/out switchers	$4,142,995	$6,787,496	$7,244,456
Payment to MBTA (Commuter Rail only)	$1,368,118	$1,368,118	$1,368,118
Total cost of switchers	$-	$53,231	$81,167
Payment to MBTA for Off Campus Users	$119,715	$119,715	$119,715
Total payment to MBTA	$4,262,710	$6,960,442	$7,445,337
Total Cost of Program	**$15,262,710**	**$17,783,306**	**$18,190,993**
Total MIT subsidy	**$9,867,711**	**$10,925,486**	**$11,944,618**
Additional subsidy over current		$1,057,776	$2,076,908
Additional Subsidy over Current assuming no parking lease savings		$1,234,912	$2,331,252

Alternatives 2a & 2b: Differential pricing by lot, 3 tiers at $2, $4, and $6, with a commuter rail subsidy of 50% or 100%

Option		**2a**	**2b**
Parking Fees	**Current**	**$2,$4,$6**	**$2,$4,$6**
Commuter Rail Subsidy		**50%**	**100%**
Current Drivers Switching to Transit		131	164
Current Drivers Switching to Carpool		55	55
Percent of current Drivers Switching		-6%	-7%
Parking Daily Revenue	$9,053	$12,747	$12,609
Annual Mobility Pass Cost		$180	$180
Off Campus Users Opt In		185	185
On Campus Users Opt Out		2,122	2,092
Total participants w T Pass	5,011	16,311	16,341
Mobility Pass Revenue	$1,361,496	$2,935,980	$2,941,380
Additional Revenue from Commuter Rail Users	$867,200	$577,667	$-
Additional Revenue from Off Campus Users	$61,937	$48,549	$33,300
Parking Revenue from Fees	$2,082,116	$2,931,737	$2,900,165
Parking Revenue from exempt and visitors	$696,362	$670,816	$670,816
Additional Revenue from occasional spots	$325,888		
Guaranteed Spot Revenue		$149,569	$149,569
Total Parking Revenue	$3,104,366	$3,752,122	$3,720,550
Total Revenue	**$5,394,999**	**$7,314,318**	**$6,695,230**
Spots required	4,814	4,628	4,594
Total Annual cost to provide parking	$11,000,000	$10,574,592	$10,497,385
Payment to MBTA w/out switchers	$4,142,995	$6,787,496	$7,244,456
Payment to MBTA (Commuter Rail only)	$1,368,118	$1,368,118	$1,368,118
Total cost of switchers	$-	$108,049	$135,985
Payment to MBTA for Off Campus Users	$119,715	$119,715	$119,715
Total payment to MBTA	$4,262,710	$7,015,261	$7,500,156
Additional Depreciated Admin costs		$58,415	$58,415
Total Cost of Program	**$15,262,710**	**$17,648,268**	**$18,055,955**
Total MIT subsidy	**$9,867,711**	**$10,333,950**	**$11,360,725**
Additional subsidy over current		$466,239	$1,493,014
Additional Subsidy over Current assuming no parking lease savings		$891,647	$1,995,630

Alternatives 3a & 3b: Differential pricing by lot, 3 tiers at $2, $6 and $10, with a commuter rail subsidy of 50% or 100%

Option		**3a**	**3b**
Parking Fees	**Current**	**$2,$6,$10**	**$2,$6,$10**
Commuter Rail Subsidy		**50%**	**100%**
Current Drivers Switching to Transit		270	304
Current Drivers Switching to Carpool		144	144
Percent of current Drivers Switching		-12%	-13%
Parking Daily Revenue	$9,053	$17,823	$17,616
Annual Mobility Pass Cost		$180	$180
Off Campus Users Opt In		185	185
On Campus Users Opt Out		2,122	2,092
Total participants w T Pass	5,011	16,311	16,341
Mobility Pass Revenue	$1,361,496	$2,935,980	$2,941,380
Additional Revenue from Commuter Rail Users	$867,200	$577,667	$-
Additional Revenue from Off Campus Users	$61,937	$48,549	$33,300
Parking Revenue from Fees	$2,082,116	$4,099,186	$4,051,584
Parking Revenue from exempt and visitors	$696,362	$670,816	$670,816
Additional Revenue from occasional spots	$325,888		
Guaranteed Spot Revenue		$149,569	$149,569
Total Parking Revenue	$3,104,366	$4,919,571	$4,871,969
Total Revenue	**$5,394,999**	**$8,481,767**	**$7,846,649**
Spots required	4,814	4,400	4,366
Total Annual cost to provide parking	$11,000,000	$10,053,941	$9,976,733
Payment to MBTA w/out switchers	$4,142,995	$6,787,496	$7,244,456
Payment to MBTA (Commuter Rail only)	$1,368,118	$1,368,118	$1,368,118
Total cost of switchers	$-	$223,010	$250,946
Payment to MBTA for Off Campus Users	$119,715	$119,715	$119,715
Total payment to MBTA	$4,262,710	$7,130,222	$7,615,117
Additional Depreciated Admin costs		$58,415	$58,415
Total Cost of Program	**$15,262,710**	**$17,242,577**	**$17,650,265**
Total MIT subsidy	**$9,867,711**	**$8,760,811**	**$9,803,615**
Additional subsidy over current		$(1,106,900)	$(64,095)
Additional Subsidy over Current assuming no parking lease savings		$(160,841)	$959,172

Alternatives 4a & 4b: Differential pricing by lot, 2 tiers at $2.25 and $7, with a commuter rail subsidy of 50% or 100%

Option		4a	4b
Parking Fees	Current	$2.25,$7	$2.25,$7
Commuter Rail Subsidy		50%	100%
Current Drivers Switching to Transit		89	123
Current Drivers Switching to Carpool		29	29
Percent of current Drivers Switching		-4%	-5%
Parking Daily Revenue	$9,053	$11,055	$10,939
Annual Mobility Pass Cost		$180	$180
Off Campus Users Opt In		185	185
On Campus Users Opt Out		2,122	2,092
Total participants w T Pass	5,011	16,311	16,341
Mobility Pass Revenue	$1,361,496	$2,935,980	$2,941,380
Additional Revenue from Commuter Rail Users	$867,200	$577,667	$-
Additional Revenue from Off Campus Users	$61,937	$48,549	$33,300
Parking Revenue from Fees	$2,082,116	$2,542,694	$2,515,887
Parking Revenue from exempt and visitors	$696,362	$670,816	$670,816
Additional Revenue from occasional spots	$325,888		
Guaranteed Spot Revenue		$149,569	$149,569
Total Parking Revenue	$3,104,366	$3,363,079	$3,336,272
Total Revenue	**$5,394,999**	**$6,925,275**	**$6,277,652**
Spots required	4,814	4,695	4,661
Total Annual cost to provide parking	$11,000,000	$10,728,591	$10,651,383
Payment to MBTA w/out switchers	$4,142,995	$6,787,496	$7,244,456
Payment to MBTA (Commuter Rail only)	$1,368,118	$1,368,118	$1,368,118
Total cost of switchers	$-	$73,872	$101,808
Payment to MBTA for Off Campus Users	$119,715	$119,715	$119,715
Total payment to MBTA	$4,262,710	$6,981,083	$7,465,978
Additional Depreciated Admin costs		$58,415	$58,415
Total Cost of Program	**$15,262,710**	**$17,768,089**	**$18,175,777**
Total MIT subsidy	**$9,867,711**	**$10,842,814**	**$11,898,124**
Additional subsidy over current		$975,103	$2,030,413
Additional Subsidy over Current assuming no parking lease savings		$1,246,512	$2,379,030

5.1 Comparison of Alternatives

All programs induce some mode shift to transit from SOV. Simply adding a Universal Pass with a 50 percent commuter rail subsidy, as is the case with option 1a, and continuing the annual price increases induces about two percent of daily drivers to campus to move to transit. It is important to note that this does not indicate that two percent of drivers switch modes completely, but rather represents a decrease in two percent in the daily number of parkers on campus. This may well take the form of 10 percent of drivers choosing to carpool or take transit one day per week.

As expected, higher parking prices encourage more people to leave their cars. Because carpools are now free, we see some shift in all alternatives. Under the most aggressive pricing option, 3a, we see significant shift to carpooling, with a little fewer than five percent of current drivers forming new carpools. Increasing the commuter rail subsidy under each option to 100 percent induces an additional 34 daily drivers to switch to transit under each program.

Comparison of Options: 50% Commuter Rail Subsidy

Option	1a	2a	3a	4a
Parking Fees	11% increase	$2,$4,$6	$2,$6,$10	$2.25,$7
Current Drivers Switching to Transit	64	131	270	89
Current Drivers Switching to Carpool	13	55	144	29
Percent of current Drivers Switching	-2%	-6%	-12%	-4%
Additional subsidy from current	$1,057,776	$466,239	$(1,106,900)	$975,103
Additional Subsidy from Current assuming no parking savings	$1,234,912	$891,647	$(160,841)	$1,246,512

By far the least costly program to MIT is alternative 3 at tiered parking pricing of $2, $6 and $10. With a 50 percent commuter rail subsidy, this alternative decreases the cost to MIT by $160,000 per year, or less than two percent of the current budget for Transit and Parking. If we include the future savings that MIT can expect to see by not needing to provide leased spaces due to decreased parking demand, this alternative may actually result in additional cost savings to MIT. Alternative 2a, when taking into account the future savings on parking, represents an increase in the Transportation budget of less than four percent. All of the daily price options are less expensive for MIT in the long run than simply increasing prices on an annual parking permit. Because these alternatives induce mode shift, increasing the Commuter Rail subsidy will cost MIT between $1,000,000 and $1,200,000 in additional payments to the MBTA, with the more expensive estimate becoming reality when parking prices are highest. Removing the current per-carpool charge for carpool spaces costs less than $75,000 in additional revenue.

Were we not dealing with real people, who have made real choices about location and lifestyle based in some part on existing parking policies, alternative 3 is clearly both the most environmentally friendly and the most financially sound option for MIT. It also provides a lower cost alternative while giving everyone a transit pass. The $2 per day rate actually saves money on a yearly basis versus the current rates. These savings notwithstanding, there may be perceptions that the new rates are not equitable if alternative 3 is adopted. Alternative 4 is the direct answer to this. In this scenario, almost 80 percent of the spaces are priced so that they provide an option that is exactly equivalent to the cost of an 11 percent parking increase, even accounting for the additional cost to each person of the Mobility Pass. While this induces more than 70 percent less mode shift from SOV travel that alternative 3, and costs MIT more than $1,200,000 per year in the long run, it may face less community objection. There is, of course, the risk in this option that the differential in prices between premium lots and all others is too great, reducing demand for premium lots significantly. Alternative 2 provides a much less steep distribution of daily pricing than either alternative 3 or 4. It still allows for people to choose a lower cost option, but encourages people to keep using the more convenient lots at a small differential in price.

When evaluating these alternatives it is important to keep in mind the flexibility that daily pricing provides. A small change now, — even if it is revenue neutral to MIT vis-à-vis an annual price increase—allows for lots to be differentiated by price to reflect demand at some future point. This can increase utilization of lots, and help MIT get the most out of its existing assets. Further, the prices here and the demand projections inherent in the cost estimates are only that, estimates. Daily pricing gives the flexibility to change prices if these estimates are less accurate than we believe them to be.

5.2 Sensitivity Analysis

We have tested the sensitivity of our model to our assumptions regarding the current demand for parking, elasticity of transit and carpool demand with respect to the price of parking, the sensitivity of parkers to the "draw" of the low priced spots available under each alternative, and the number of current drivers who have viable access to mass transit. While mode switch is sensitive to many of these assumptions, total revenue as a result of these programs is not. If fewer people switch from parking to mass transit, this actually results in a small increase in revenue on average. The robustness of these results is encouraging.

Specifically, in our calculations we have assumed that people park 46 weeks per year. A 10 percent change in this assumption in either direction results in a 27 percent change in carpool mode shift and an 18 percent change in transit mode shift. This translates to a $250,000 decrease in our subsidy calculations for every 10 percent change in the number of weeks people park per year, or a three percent change in total subsidy.

Regarding the elasticity of demand for mass transit, we find that a 25 percent decrease in this elasticity results in a decrease of 25 percent of SOV drivers switching to transit, but an increase in the required subsidy of only $20,000, or 0.2 percent. For demand elasticity for carpools we find that a 50 percent decrease in this elasticity also decreases the number of predicted SOV drivers switching to carpool by 50 percent, however, this only increases MIT's subsidy by $40,000.

For parking demand, we have assumed that the low price and premium spots fill up first, and then the middle spots. If we relax this assumption for our worst-case scenario for revenue (Premium spots fill up last), 23 percent fewer people switch to mass transit, and 35 percent fewer people switch to carpool, with the inverse result if the low price spaces fill up last. This is equivalent to a $360,000 decrease in revenue or slightly less than four percent.

Lastly, we have assumed an average of our low, medium, and high estimates of the number of current drivers who have access to transit. We find that our transit mode shift is very sensitive to this assumption. Using our low estimate results in a 57 percent decrease in mode shift from SOV to transit, although this is slightly mitigated by more carpool users. However, these changes only increase the required subsidy by less than $30,000, since these people are now parking on a daily basis.

The methodology behind the estimates provided above is presented in Appendix 4.

5.3 Alternative Futures for MIT

As MIT continues to expand over the next 10 to 20 years, the sustainability of the current parking policies is questionable. We have prepared the following scenarios to illustrate the costs of expansion if the "status quo" continues versus a transformation to the Mobility Pass recommended in Section 2, under the most aggressive pricing alternative. Both scenarios have been prepared to accommodate an additional 1,000 employees on the main campus.

5.3.1 Scenario 1: Status Quo

Under this scenario we assume that these new employees have similar location preferences as current employees, and thus have a similar drive alone mode share. At 37 percent current SOV mode share, this requires an additional 370 spaces to be constructed. Furthermore, as we have seen, the most desirable buildable spaces are filled with either lots or garages. We estimate that this would require replacing approximately 400 current spaces, based on the current ratio of employees to spaces. Based on the incentives given by the city of Cambridge, we assume that MIT will build only underground spaces, and that these spaces will cost in the vicinity of $100,000 per space (or $10,000 per year at eight percent over 30 years).

Based on these calculations, MIT must build approximately 770 new spaces to accommodate the additional drivers and to replace the spaces lost to construction. This will cost approximately $7.7 million per year, in perpetuity above and beyond the current parking and transportation budget. Furthermore, this will require that MIT negotiate with the City of Cambridge Planning Department, as this will require that MIT go beyond the number of spaces that it can provide without needing to be subject to review by Cambridge.

5.3.2 Scenario 2: Mobility Pass & Differentially Priced Parking

We assume in this scenario that all new employees have the same drive alone mode share of 33 percent as current employees under the predicted effects of option 3b (Tiered

Pricing of $2, $6, $10 plus a Mobility Pass that includes Commuter Rail). Implicit in this assumption is that higher subsidy levels and different incentives will not affect the location choice, which is clearly not the case. Thus, this 33 percent mode share is conservatively high: it is likely to be significantly lower. Thus, rather than needing to build 370 additional spaces as above, we only need to build 330 spaces. We still need to build spaces underground to replace those being lost to construction. However, based on our estimates of switching from driving alone in Section 5.1, we need 450 fewer spaces for current employees. Because we have estimated only the short-term impacts of this switch, we can expect that more than 450 people witch from driving alone in the long term, but using these short-run switchers again provides us with a conservative estimate.

We then need replace the 400 spaces we lose to construction with only 280 additional spaces to accommodate the additional employees. These costs are only $2.8 million, almost $5 million less than those of scenario 1. Furthermore, the additional revenue MIT receives from this parking structure pays for the complete cost of providing a Mobility Pass that includes a full Commuter Rail subsidy. Thus, in the long run, we have created a more sustainable plan that provides significant savings to the MIT administration. Furthermore, because of the decrease in parking demand, there is no need to petition Cambridge for an increase in the number of spaces that MIT is allowed to have under its control, and deal with the uncertainty associated with the negotiations with the City.

This scenario also has substantial non-monetary benefits. The incentives to switch modes from driving alone to transit will create a campus where people live closer, and have shorter commutes. The differential pricing structure allows MIT the flexibility to change prices equitably in the long run, recouping the costs of providing parking. Lastly, it has the potential, as we have shown throughout this report, to create a more sustainable campus, and to position MIT as a leader in transportation demand management.

The environmental impact of this scenario is also worth noting. This scenario involves a 13 percent decrease in those who drive alone to get to campus, including 270 people switching to transit and 144 to carpooling. For simplicity's sake, we will assume that the switch takes place as people switching 100 percent of the time rather than more people switching some of the time. If we take the average number of vehicle miles traveled to get to campus used in the thesis producing the graph in the introduction, 8.8 miles, we can calculate that 2,165 less miles are being traveled because of the switch to transit. If we assume that everyone carpools in the smallest groups possible, or groups of two, then 633 less miles are traveled due to the switch to carpooling. That is a total of just under 2,800 less miles travels. The EPA offers an estimated average 23.9 miles per gallon fuel efficiency for the current private fleet, which is greater than the 20 miles per gallon used in the Groode thesis. Using this fuel efficiency, the switches result in a savings of 117 gallons of gas per day of commuting. Multiplied by the five days per week over 46 weeks in the year, the total gas savings is about 27,000 gallons. EPA estimates that a single gallon of gasoline produces 19.4 pounds of carbon dioxide, resulting in an estimated reduction of about 520,000 pounds of carbon dioxide. The estimated reduction is four percent of Groode's estimated contribution from commuters and one percent reduction of transportation's total contribution.

This was a very brief calculation to demonstrate that there could be significant emissions reductions from the proposed Universal Transportation Program. Of course, taking transit is not emissions free, but it is far more efficient and the trains are currently running with or without these additional riders, so we left this piece out of our very simple calculations of environmental impact. A much more intensive calculation should take place to determine the true impact of the mode switch, however, this initial estimate again indicates that this scenario can have a significant impact. Combined with technological improvements such as biodiesel, and shifts in housing location decisions, transportation's contribution to energy use and emissions should be even greater. Finally, this proposal establishes a new mechanism that can be used in a more dramatic fashion in the future to manage demand at even higher levels as the university deems necessary.

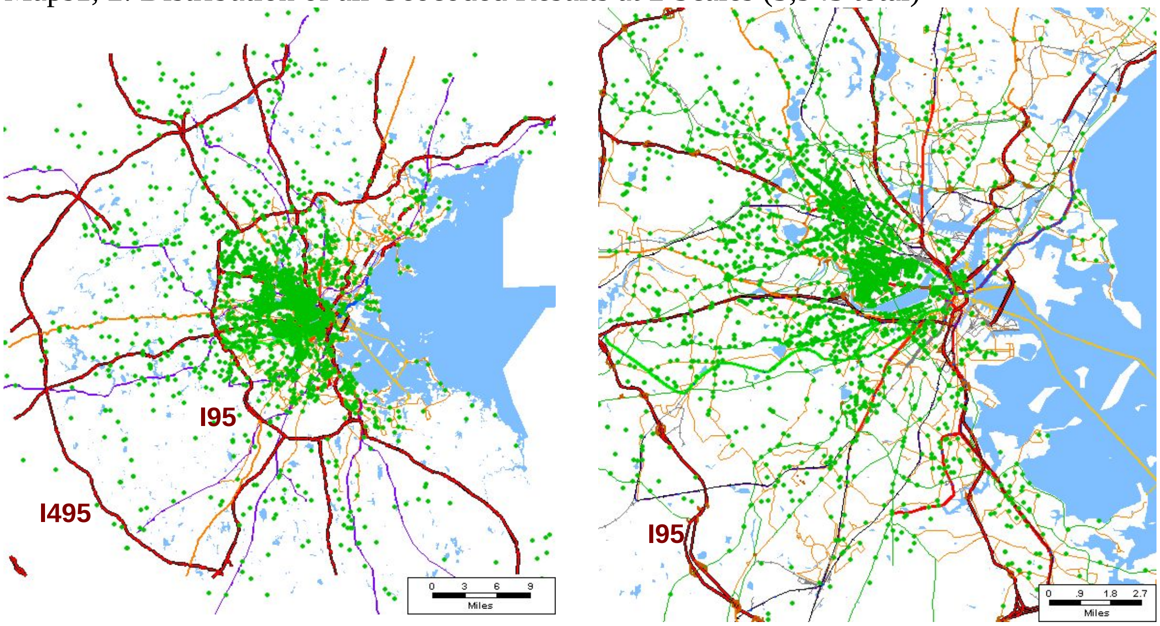
6 Appendices

6.1 Appendix 1: Housing Location and Commuting Behavior

In this section, the relationship between housing location and commuting behavior is analyzed through by mapping the closest intersections of the homes of respondents to the 2006 MIT Transportation survey. These entries were geocoded in GIS and input into a TransCAD-based transportation network assignment model containing both the Boston region highway and street and public transportation (MBTA) networks. The networks in the TransCAD were originally created by Multisystems, Inc. in 1996-97 and the Central Transportation Planning Staff for the Metropolitan Area Planning Council and were significantly updated in 2006-07 by Mikel Murga, Research Associate at MIT, for use for this report.

We were able to geocode 5,945 intersections that represent respondents' home locations, shown below.

Maps1, 2: Distribution of all Geocoded Results at 2 Scales (5,945 total)

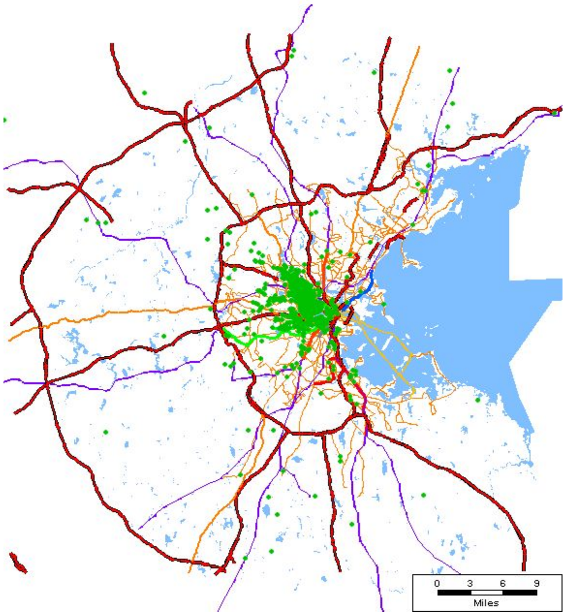


Visualizing this distribution while being able to categorize these locations according to type of student or employee, mode of commuting to MIT, type of pass held, and other categories, provides insight into the relationship between housing location choice and commuting patters. Many MIT commuters are located along transit and commuter rail lines. These transit lines are identified in the map by the colored lines corresponding to the colors of MBTA lines (green, blue, orange, and red). Purple lines indicate Commuter Rail. However, a number of MIT commuters have chosen to locate in areas that are not covered by public transit, a significant number of which are outside of the I95 loop.

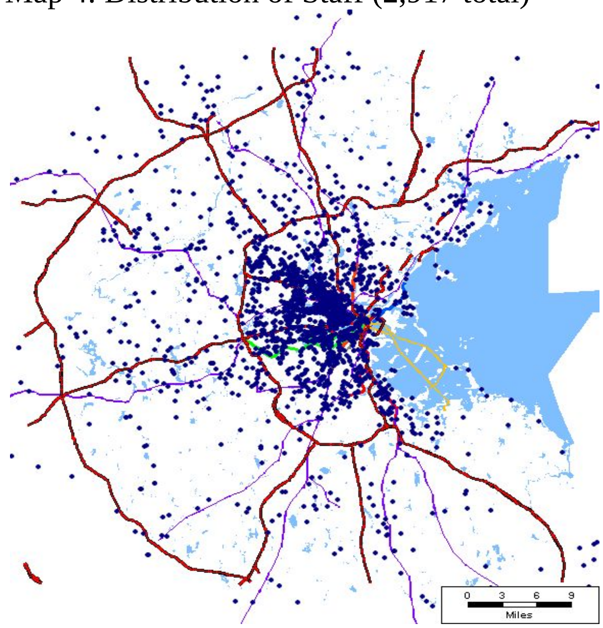
Because of this location choice, not all MIT students and employees can be expected to easily take transit to MIT.

The following two maps show the locations of students and staff separately.

Map 3: Distribution of Students (3,024 total)

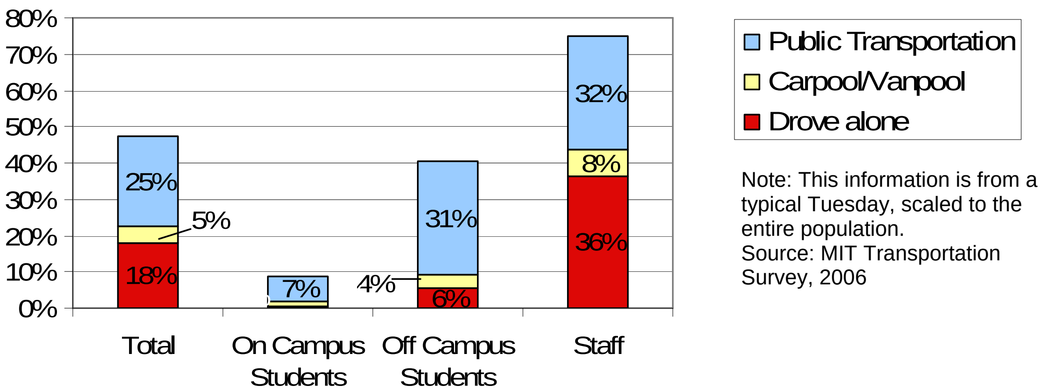


Map 4: Distribution of Staff (2,917 total)



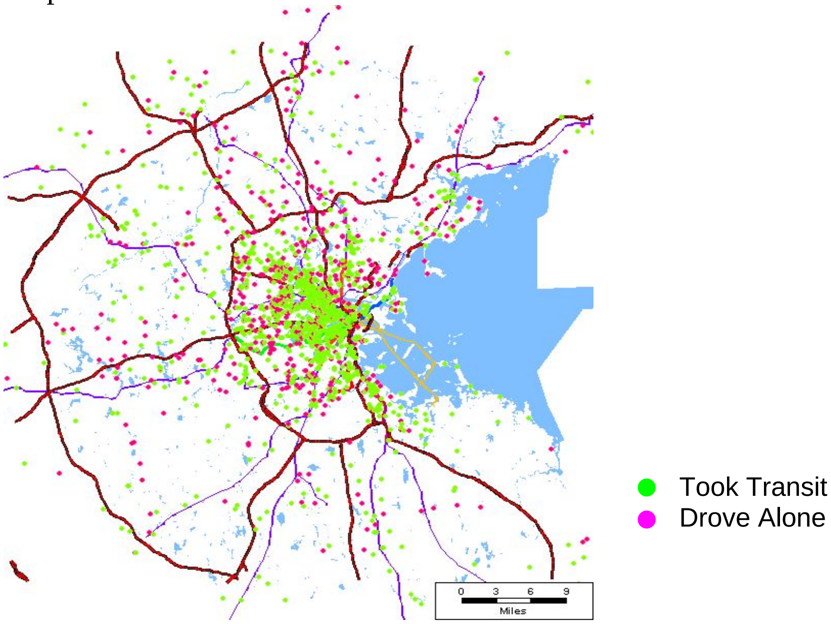
These different groups, probably largely due to their level of dispersion, have very different mode shares. Off campus students have only a 6 percent drive alone mode share to commute to MIT, whereas staff have a 36 percent mode share. The overall drive alone mode share for commuting to campus is only 18 percent, lowered significantly by the on and off campus students, most of whom live very close to campus.

Table 1: Percentage of Population that Commute to MIT using 3 Modes



Using all of the mapped results, we created a map differentiating between those who take transit and those that drive, to determine whether there is a geographical pattern. Not surprisingly, closer to campus where there is more extensive public transit, more commuters are taking transit. Further away from the center, where a higher drive alone mode share is expected, we find an overall mixture between those who drive and take transit. This indicates that although many have chosen to locate beyond walking distance to transit, transit is still a feasible option for a large geographic area. Where there are not options, carpool could be encouraged to decrease the percentage of those who drive alone to work.

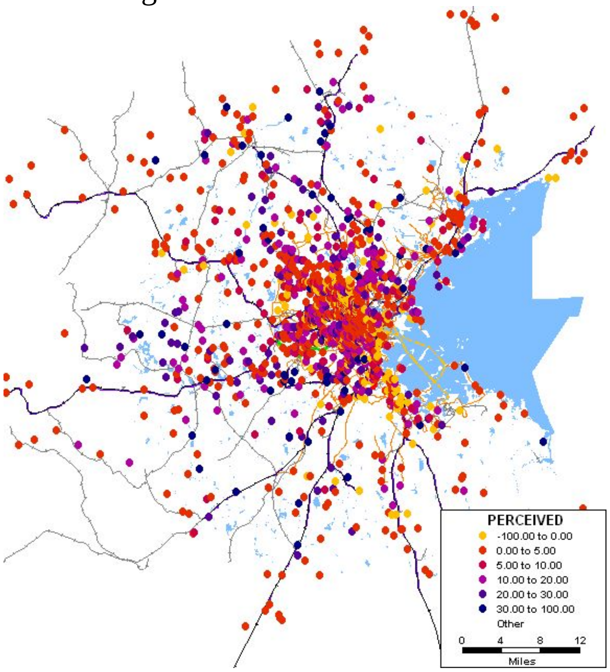
Map 5: Distribution of Staff Commuters and Method of Commuting



Using the private auto and public transportation networks in the TransCAD model, we compared the home-to-work or home-to-school travel times using the point closest to 77 Massachusetts Avenue as the destination. Not all respondents would be destined for this part of campus, but it gives us a way to compare the different times required to take transit or drive, which then enables us to estimate the number of commuters for whom taking transit is a viable option.

First we compared the reported travel times versus the travel times estimated in the model and mapped the difference. In Map 6 below, the lightest colored dots indicate that there is little difference between the reported, or perceived, time and the model times. Darker colors indicate that the perceived time was greater.

Map 6: Difference between Perceived and Model Times for Reported Method of Commuting to MIT



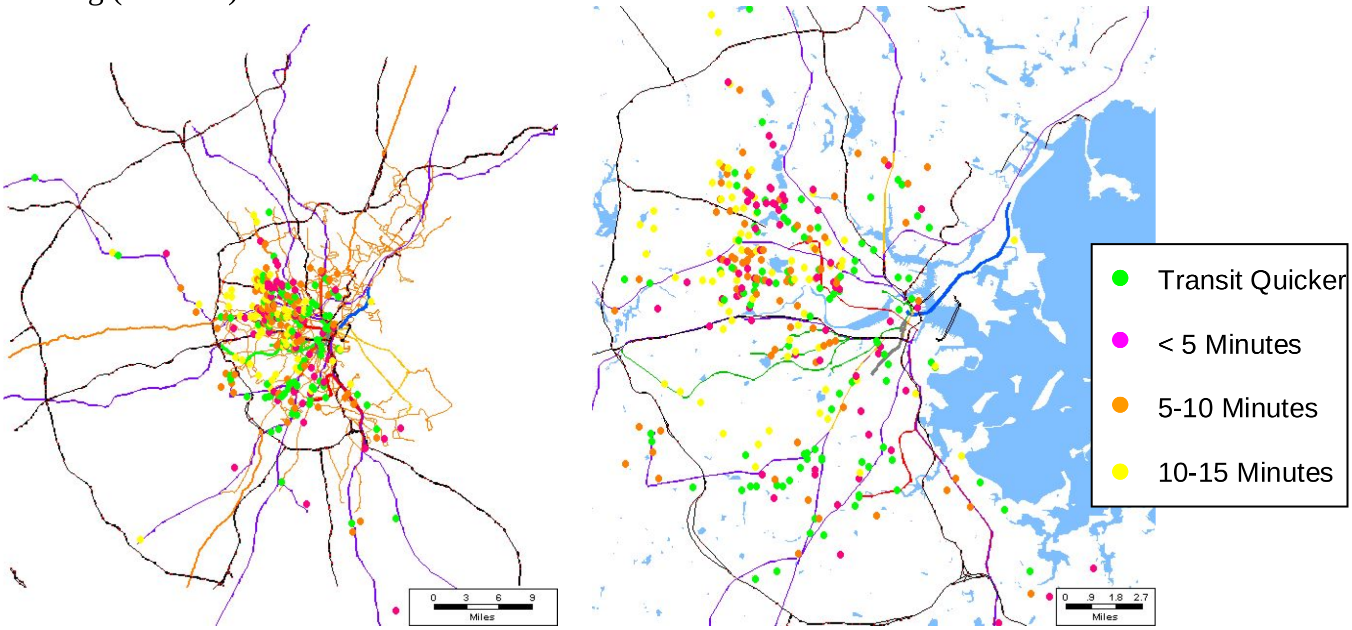
To determine the time difference between driving and taking transit for each respondent that we were able to geocode, we used the reported times for driving from the MIT Transportation Survey. We believe the TransCAD model underestimates driving times by using average speeds as reported by the Boston Metropolitan Planning Organization. Respondents probably will also underestimate driving time for various reasons, for example they may not include the time to walk from a parking spot to the office. However, using perceived time from the survey should underestimate driving time less than using the model times. We used the TransCAD model times for transit because we believe that people tend to perceive transit times as longer.

Using these calculations, we determined the drivers for whom taking transit is:

a. faster
b. less than five minutes longer;
c. five to ten minutes longer;
d. ten to 15 minutes longer;
e. 15 to 20 minutes longer;
f. 20 to 25 minutes longer;
g. 25 to 30 minutes longer; and
h. more than 30 minutes longer.

The following maps show only up to 15 minutes longer, because it is difficult to visually interpret a map with seven categories (up to 30 minutes). It is also more reasonable to imagine that someone might think taking transit is a possibility when it only takes 15 minutes longer. An additional 30 minutes is probably viewed much more negatively.

Maps 7, 8: Drivers for Whom Taking Transit is Quicker or up to 15 Minutes Longer than Driving (2 Scales)



There were 364 mapped survey respondents who drive even though taking transit is quicker or up to 15 minutes longer. Scaled up to the population level, this would be about 900 people for whom transit is a reasonable option in regards to time difference. Of course, other factors will be critical when considering the feasibility of taking transit, such as work schedule, other responsibilities such as dropping children off at school, whether or not the commuter already owns a car due to a suburban housing location. If a person already owns a car, he/she may be more likely to drive it to work because most of his/her other traveling is already done in a car.

Issues and Concerns

Location is not the only factor in play when considering why commuters choose certain modes to get to work, and when trying to change commuting behavior. However, this spatial analysis indicates that there are options available for commuters to MIT. This also raises the question of policy related to location decisions. If MIT policy can encourage future housing purchases to be made nearer to Commuter Rail, or preferably even closer to MIT, reducing the mileage needed to travel, then the above spatial analysis could change dramatically and the commuting choices could change dramatically over the long-term. Any consideration of commuting behavior should include consideration of where people have chosen to live.

6.2 Appendix 2: Methodology for Analyzing 2006 Transportation Survey.

In October 2006, MIT distributed a commuter transportation survey via e-mail to all students, faculty and staff with an MIT e-mail address. We were provided with the data from this survey, stripped of any identifying information, as well as MIT records of what type of transit and/or parking permits each anonymous invitee purchased in both October and November 2006. Because more people purchased transit passes in November than October, the transit behavior for October was used as baseline. From that behavior we created subgroups for those users who changed their purchasing behavior between October and November (e.g. they had a transit pass in October, but did not purchase a pass in November)

The survey had a response rate well over 50%. However, neither the invitee list nor the response rate was perfectly representative of the population. Some groups were not represented at all (freshmen), and some groups were under-represented (service staff). Furthermore, there was a clear pattern for those people who purchase either a transit pass or parking permit to respond, whereas those who did not purchase a pass(i.e. walked, biked, or lived on campus) responded at a less frequent rate.

To correct for this bias, we developed a scaling factor for each combination of employee/student type and parking permit/transit pass behavior. This factor is applied to all survey results in order to scale to the population. A new factor must be determined for each question, as the response rate varies significantly between questions. This methodology has been applied to the estimates outlined above, via the methodology outlined in Appendices 2 and 3. A sample scaling factor is included below.

Scaling Factor for entire survey: Respondents who Qualify for Transportation Benefits to Qualified Population

	Undergraduate student (lives off campus)	Graduate student (lives off campus)	Other student	Faculty	Other academic staff	Admin staff	Support staff	Service staff	Sponsored research staff	Medical staff	Unknown	Undergrad (lives on campus)	Graduate student (lives on campus)	Total
No Park & No Pass	1.98	2.18	1.75	2.30	2.60	1.88	2.09	12.63	2.21	3.67	1.00	2.89	1.84	2.34
No Park & Dropped Pass	1.40	1.93	0.00	0.00	2.00	0.00	4.00	0.00	1.00	0.00	0.00	2.38	1.21	1.76
No Park & Bus Pass	1.36	1.58	0.00	1.50	1.65	1.39	1.39	9.50	1.30	1.00	0.00	1.27	1.46	1.52
No Park & Bus Pass Switch	1.42	1.79	0.00	0.00	5.00	1.00	1.40	0.00	0.00	0.00	0.00	1.25	2.50	1.63
No Park & Subway Pass	1.63	1.54	1.00	1.44	1.76	1.30	1.37	10.25	1.55	1.25	0.00	1.66	1.62	1.55
No Park & Subway Pass Switch	1.43	1.72	0.00	1.00	1.57	1.50	1.56	0.00	1.56	0.00	0.00	2.45	1.44	1.67
No Park & Combo Pass	1.38	1.45	1.00	1.38	1.77	1.23	1.34	7.50	1.63	2.50	0.00	1.92	1.81	1.56
No Park & Combo Pass Switch	1.60	1.49	0.00	1.00	1.38	1.67	1.07	4.00	2.00	0.00	0.00	1.86	1.38	1.49
No Park & Commuter Pass	0.00	1.53	0.00	1.29	1.60	1.14	1.27	4.75	1.38	1.00	0.00	0.00	1.75	1.38
No Park & Commuter Pass Switch	0.00	1.50	0.00	0.00	3.00	1.00	4.00	0.00	2.00	0.00	0.00	0.00	0.00	1.92
Occasional Park & No Pass	1.00	2.00	1.00	1.78	1.62	1.51	1.44	13.20	1.48	1.40	1.00	0.00	0.00	2.06
Occasional Park & Bus Pass	1.00	1.50	0.00	0.00	1.20	1.18	1.00	3.00	1.20	0.00	0.00	0.00	0.00	1.22
Occasional Park & Subway Pass	0.00	1.30	0.00	1.26	1.31	1.11	1.22	7.00	1.50	1.00	0.00	0.00	1.00	1.26
Occasional Park & Combo Pass	1.00	1.71	0.00	1.33	1.27	1.16	1.45	6.00	1.25	1.20	0.00	0.00	0.00	1.35
Occasional Park & Commuter Pass	0.00	1.50	0.00	1.29	1.25	1.16	1.23	3.00	1.18	1.00	0.00	0.00	0.00	1.21
Regular Park	1.60	1.93	1.00	2.04	1.69	1.33	1.50	5.12	1.54	1.69	0.00	1.61	1.74	1.67
Total	1.83	1.86	1.50	1.92	1.93	1.32	1.46	7.37	1.59	1.66	1.00	2.77	1.77	1.88

6.3 Appendix 3: Methodology for Estimating Cost of Universal Pass

6.3.1 Qualified Population

Only students, and employees who are paid and work more than half-time, currently qualify to purchase subsidized transit passes. Additionally, those people who work at off-campus locations were removed from the main population, as the transit service they have access to varies significantly from that on the main campus. In calculating participation, these people were assumed to have the option to opt-in to the Universal Pass program at the same price as on-campus users. The estimates for this population are detailed separately.

Qualified Population

Undergraduate student (lives off campus)	994
Graduate student (lives off campus)	4003
Other student	36
Faculty	994
Other academic staff	1311
Administrative staff	1853
Support staff	1478
Service staff	840
Sponsored research staff	1375
Medical staff	106
Unknown	12
Undergrad (lives on campus)	3180
Graduate student (lives on campus)	2066
Total	18248

6.3.2 Current Usage

Survey respondents indicated how many trips they had taken on each mode or combination of modes in the previous week. Less than 2% of respondents indicated that they had taken more than 30 trips on all modes combined. These results were modified to restrict responses to no more than 30 linked trips per week. Results were then scaled by mode and what type of parking or transit pass they held, in order to determine average usage by each group.

MBTA usage by type of pass held and employment/student status (trips/week)

Type		Comm. Rail + Subway	Comm. Rail	Subway	Bus + Subway	Expr. Bus	Local Bus	Total trips
Passholder (not from MIT)	**Total**	**0.82**	**0.21**	**4.18**	**1.93**	**0.02**	**1.39**	**8.56**
	Staff	0.96	0.19	4.70	2.96	0.00	1.04	9.85
	Student	0.71	0.24	3.76	1.12	0.03	1.68	7.53
	Undergrad	1.17	0.33	4.00	0.17	0.00	1.00	6.67
	Grad	0.61	0.21	3.71	1.32	0.04	1.82	7.71
	Undergrad (off campus)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Undergrad (on campus)	1.17	0.33	4.00	0.17	0.00	1.00	6.67
	Grad (off campus)	0.68	0.16	3.88	1.32	0.04	1.84	7.92
	Grad (on campus)	0.00	0.67	2.33	1.33	0.00	1.67	6.00
Non Passholder	**Total**	**0.07**	**0.04**	**1.78**	**0.23**	**0.03**	**0.62**	**2.77**
	Staff	0.09	0.06	1.71	0.29	0.03	0.39	2.57
	Student	0.06	0.03	1.79	0.22	0.03	0.67	2.81
	Undergrad	0.07	0.03	1.49	0.22	0.03	0.76	2.59
	Grad	0.05	0.04	2.10	0.22	0.04	0.57	3.02
	Undergrad (off campus)	0.05	0.01	1.55	0.24	0.04	1.12	3.01
	Undergrad (on campus)	0.08	0.03	1.47	0.21	0.02	0.66	2.47
	Grad (off campus)	0.04	0.04	2.27	0.20	0.04	0.56	3.15
	Grad (on campus)	0.07	0.04	1.83	0.24	0.03	0.58	2.80
Bus Passholder	**Total**	**0.01**	**0.02**	**1.41**	**0.72**	**0.28**	**5.95**	**8.39**
	Staff	0.02	0.00	1.40	0.79	0.30	6.79	9.31
	Student	0.01	0.04	1.42	0.67	0.26	5.39	7.79
	Undergrad	0.01	0.02	1.13	0.64	0.36	5.26	7.41
	Grad	0.01	0.04	1.61	0.69	0.19	5.49	8.03
	Undergrad (off campus)	0.01	0.03	1.11	0.63	0.42	5.70	7.90
	Undergrad (on campus)	0.00	0.00	1.20	0.68	0.11	3.40	5.39
	Grad (off campus)	0.01	0.05	1.61	0.52	0.21	5.95	8.34
	Grad (on campus)	0.00	0.00	1.66	1.62	0.10	2.99	6.37
LinkPass Passholder	**Total**	**0.07**	**0.03**	**6.80**	**1.81**	**0.11**	**1.32**	**10.13**
	Staff	0.05	0.03	6.28	2.51	0.12	1.47	10.45
	Student	0.10	0.02	7.39	1.02	0.09	1.14	9.77
	Undergrad	0.19	0.08	4.40	1.34	0.20	1.86	8.07
	Grad	0.09	0.02	7.72	0.98	0.08	1.06	9.94
	Undergrad (off campus)	0.00	0.00	5.32	1.75	0.21	2.55	9.82
	Undergrad (on campus)	0.32	0.12	3.79	1.07	0.20	1.40	6.90
	Grad (off campus)	0.10	0.02	8.45	1.00	0.08	1.06	10.70
	Grad (on campus)	0.07	0.02	3.77	0.84	0.07	1.05	5.81
Commuter Passholder	**Total**	**5.11**	**1.80**	**2.04**	**0.50**	**0.08**	**0.33**	**9.86**
	Staff	5.37	1.91	1.94	0.52	0.09	0.31	10.14
	Student	3.31	1.06	2.72	0.36	0.08	0.42	7.94
	Undergrad	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Grad	3.44	1.11	2.83	0.37	0.08	0.43	8.26
	Undergrad (off campus)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Undergrad (on campus)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Grad (off campus)	3.80	1.22	2.89	0.39	0.09	0.48	8.86
	Grad (on campus)	0.00	0.00	2.25	0.25	0.00	0.00	2.50

Type		Comm. Rail + Subway	Comm. Rail	Subway	Bus + Subway	Expr. Bus	Local Bus	Total trips
Occasional Parker (no T Pass)	**Total**	**0.07**	**0.05**	**0.96**	**0.14**	**0.01**	**0.20**	**1.44**
	Staff	0.08	0.06	0.98	0.12	0.01	0.18	1.43
	Student	0.00	0.00	0.72	0.34	0.09	0.38	1.53
	Undergrad	0.00	0.00	1.00	0.00	0.00	2.00	3.00
	Grad	0.00	0.00	0.71	0.27	0.09	0.27	1.33
	Undergrad (off campus)	0.00	0.00	1.00	0.00	0.00	2.00	3.00
	Undergrad (on campus)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Grad (off campus)	0.00	0.00	0.73	0.27	0.09	0.27	1.36
	Grad (on campus)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Regular Parking Permit Holder	**Total**	**0.05**	**0.02**	**0.81**	**0.12**	**0.01**	**0.13**	**1.14**
	Staff	0.05	0.03	0.64	0.11	0.01	0.11	0.95
	Student	0.05	0.01	1.69	0.16	0.02	0.26	2.19
	Undergrad	0.00	0.00	1.32	0.05	0.03	0.34	1.74
	Grad	0.05	0.01	1.73	0.18	0.02	0.25	2.24
	Undergrad (off campus)	0.00	0.00	1.30	0.20	0.10	0.60	2.20
	Undergrad (on campus)	0.00	0.00	1.32	0.00	0.00	0.25	1.57
	Grad (off campus)	0.09	0.03	1.46	0.10	0.00	0.27	1.96
	Grad (on campus)	0.04	0.00	1.81	0.20	0.03	0.25	2.33

6.3.3 Off-Campus employees

3,402 people who would otherwise qualify to purchase a transit pass were excluded from our initial results because they work primarily at an off campus location. These users were assumed to opt-in to a Universal Pass Program at the same rate as they currently purchase subsidized transit passes.

Off Campus Employees Transit Revenue and Subsidy

Type	Number	Universal Pass	Current
Period Cost		$15	Varies ($15 - $150+)
Commuter Rail Subsidy		50%	Variable
Non Passholder	3170		
Bus Passholder	13	$2,271	$2,347
LinkPass Passholder	138	$24,108	$47,413
Commuter Rail Passholder	8	$9,416	$12,177
Occasional Parker (no T Pass)	26	$4,542	$-
Regular Parking Permit Holder	47	$8,211	$-
Total Employee Contribution	3402	$48,549	$61,937
MIT Subsidy		$78,208	$57,778

6.3.4 Scaling Factor from November to Annual

Because no month is 100% representative of an entire year of transit behavior, we cannot simply scale a month’s costs and usage by 12 in order to result at annualized costs. To that end, we derived a scaling factor to scale the total transit passes purchased in November to the annual transit passes purchased for students and employees. We then used this scaling factor as a proxy for occasional usage by non-passholders. The scaling factor for undergraduates is greater than 12 because November was a particular low point for purchases as compared to the other months of the semester. Undergraduate pass purchasing is much less regular than purchasing behavior by either employees or Graduate students, and is thus more difficult to predict.

Annual Scaling Factor

Passes Purchased	Nov-07	Annual	Scale
Employees	2991	34835	11.65
Graduate Students	1849	18849	10.19
Undergraduates	400	4951	12.38

6.3.5 "Occasional" Usage

A key component of the cost of a Universal Pass program will be the cost of current usage by non-passholders. This was calculated for those people who did not purchase a transit or parking permit and those people who only purchased a parking permit for both students and employees based on the average usage derived above. Additionally, usage by current passholders that is not covered by their pass was derived (for example, bus pass holders who take the subway).

Annual spend on transit for people who do not purchase a transit pass

	All	Employees	Students
Non Passholders	$2,214,763	$378,135	$1,836,628
Occasional Parkers	$76,594	$70,965	$5,629
Regular Parkers	$434,395	$326,542	$107,853
Passholders not through MIT	$61,046	$28,767	$32,278
Passholder non-covered usage	$255,478	$120,258	$135,220
Total	**$3,042,276**	**$924,667**	**$2,117,609**

6.3.6 Current Costs and Subsidies

We then calculated the current cost of the program for qualified on-campus participants for on and off campus graduates and undergraduates, and for employees at both the current subsidy rate for commuter rail and at a 50% subsidy level.

Costs and Subsidies at current commuter rail subsidy

		All	Employees	Students
	Bus Pass Subsidy	$141,179	$57,924	$83,255
+	Link Pass Subsidy	$1,272,178	$714,636	$557,543
+	Commuter Subsidy	$500,918	$444,435	$56,483
=	**Total MIT subsidy**	**$1,914,276**	**$1,216,995**	**$697,281**
	Bus Pass Contribution	$89,317	$36,646	$52,671
+	Link Pass Contribution	$1,272,178	$714,636	$557,543
+	Commuter Rail Contribution	$867,200	$782,035	$85,165
=	**Total Student/Emp Contribution**	**$2,228,696**	**$1,533,317**	**$695,379**
=	MBTA Revenue through MIT	$4,142,972	$2,750,311	$1,392,660

Costs and Subsidies at 50% Commuter Rail Subsidy

		All	Employees	Students
	Bus Pass Subsidy	$141,179	$57,924	$83,255
+	Link Pass Subsidy	$1,272,178	$714,636	$557,543
+	Commuter Subsidy	$684,059	$613,235	$70,824
=	**Total MIT subsidy**	**$2,097,417**	**$1,385,795**	**$711,622**
	Bus Pass Contribution	$89,317	$36,646	$52,671
+	Link Pass Contribution	$1,272,178	$714,636	$557,543
+	Commuter Rail Contribution	$684,059	$613,235	$70,824
=	**Total Student/Emp Contribution**	**$2,045,555**	**$1,364,516**	**$681,038**
=	MBTA Revenue through MIT	$4,142,972	$2,750,311	$1,392,660

6.3.7 Opt Outs

Based on the costs of the program, we estimate those people who have an interest in opting out, based on survey responses scaled to the qualified population. Because they have demonstrated commitment to taking transit we assumed that all current MBTA passholders remain in the program. We further assume that due to variability in month to month costs, all people who spend at least 80% of program costs ($12/month on MBTA services remain in program). We assume that all regular parkers stay in the program. They are mostly located outside of an area where they could switch to walking or biking on a daily basis, so while they may have incentive to switch to a transit pass from parking, they are unlikely to give up both a transit pass and a parking spot. Furthermore, we assume that 50% of walkers and bikers who spend less than $12 per month stay in the program, both because their usage is variable on a month to month basis, and because the convenience of having the pass gives them little incentive to opt-out, even if it is not in their strict monetary interest every month. Lastly, we assume that 90% of occasional parker who do not have a T Pass and spend less than $12 per month on transit will stay in the program, as they are somewhat similar to the walkers/bikers, except that they have the added incentive of wanting to be able to park on campus occasionally.

Opt Out Under 50% Commuter Rail Subsidy

Type	Spend more than $12/month on MBTA?	Number	Opt Out?
Current subsidized T Pass purchasers	Yes	5,011	No
Current pass purchaser non-subsidizes	Yes	85	No
Regular parkers	Yes	1,039	No
Regular parkers	No	2,979	No
Walkers/bikers	Yes	4,735	No
Occasional Parkers	Yes	153	No
Walkers/bikers	No	4,172, of which 2,086 opt out	Yes (50%)
Occasional Parkers	No	360, of which 36 opt out	Yes (10%)

If the commuter rail subsidy is increased from 50% to 100%, we can expect that 30 fewer people will opt out, as the additional money they spend on occasional commute rail usage will give them an incentive to keep the Mobility Pass.

6.3.8 Program Costs

Base on the numbers derived above, we can then estimate the costs for the Universal Pass program at both a 50% and 100% commuter rail subsidy level.

Current T Subsidy Program Costs vs. Universal Pass Projected Costs

	Current	Universal Pass	
Monthly Cost to Participate		$15	$15
Commuter Rail Subsidy	37%	100%	50%
Qualified Population	18,248	18,248	18,248
Total Participants	5,011	16,156	16,126
Covered LinkPass Usage by Participants	$2,544,357	$5,794,218	$5,342,327
Covered Bus Pass Usage by Participants	$230,497	$0	$0
Covered Comm and Exp. Bus Usage by Partic.	$1,368,118	$1,368,118	$1,368,118
MIT Payment to MBTA	**$4,142,972**	**$7,162,336**	**$6,710,445**
Participant Contribution for Bus Pass	$89,317	$0	$0
Participant Contribution for Link Pass	$1,272,178	$2,908,011	$2,902,636
Participant Contribution for Commuter Rail	$867,200	$0	$577,667
MIT subsidy	**$1,914,276**	**$4,254,325**	**$3,230,141**
Uncovered usage by participants	$255,478	$0	$451,564
Uncovered usage by non-participants	$2,786,798	$22,912	$23,239
Total Fares to MBTA by MIT population	$7,185,247	$7,185,247	$7,185,247

6.4 Appendix 4: Methodology for Analyzing Revenue and Costs.

Estimating the expected revenues from a tiered parking price system required creating a model that predicts the number of people who switch to taking the T, walking or biking, or taking a carpool based on a tiered pricing structure. We then modeled the projected impact on costs and revenue based on expected daily usage of parking spaces from those who stay in the program

6.4.1 Model Inputs

Distribution of premium, medium and low priced lots. Based on observed demand, with the assistance of L. Brutti, lots are assigned to each tier.

Visitor demand at lots. This is assumed to remain steady at current demand.

Demand for lots (low priced lots fill up first or high priced lots fill up first). The number of expected switchers will vary significantly based on how location sensitive people are. If more people prefer walking longer distances but paying less, we can expect that there will be fewer people who switch to public transit, and vice versa. We have estimated results for each extreme, and reported the averages in the above sections of the report.

Current number of parking permits issues (Regular Commuter and Occasional). These are derived from the survey results as detailed above

Current number of drivers to campus (Regular Commuter, Occasional & Other). These are derived from mode share on each day as reported in the survey, scaled to the population, averaged over a week.

Current number of drivers with accessibility to mass transit. Based on a geocode of survey respondent's street intersections we have predicted the amount of time it would take all drivers to commute to MIT if they were to switch to transit using a GIS-based network model of the Boston region's road and public transit network. We then calculate the difference between their predicted transit time and their reported commute time for driving, adding additional access time for transit to correct for model deficiencies. From this we can derive low, medium and high estimates of those people who have sufficient access to transit to consider switching. The low range are only those people who would save time by switching to mass transit; the middle are those people who would only add 5-10 minutes to their commute-to-work, and the high end are those people who would add less than 20 minutes in each direction to their commute to work. We estimate results for each of these groups, and then use an average of the three.

Current % of commuter rail passes out of total transit passes. Based on the survey data we find that 12.15% off all transit passes sold are commuter rail users. We assume that this is a proxy for the degree of access people have to commuter rail in the population.

Demand elasticity for transit with respect to the real price of parking. We calculate that the "real" price of parking is the price as compared to transit. This then allows us to calculate a change in the price of parking that results either from a change in price of the alternative, or in the cost of parking itself. That is to say, a decrease in the average daily transit price of $1 has the same effect as an increase in daily parking price of $1.

Although there is little consensus on the magnitude of the cross-price elasticity of demand for transit with respect to parking, an estimate in the vicinity of 0.05 seem to, at the very least, err on the conservative side. Using this estimate would imply that for every 20% increase in the price of parking, demand for transit increases by 1%. The common usage of this elasticity would be to apply it to the whole population, some of whom have good access to transit, and others who do not.

Rather than applying this estimate to the whole population, we instead use an elasticity of 0.2, and apply it to only those people who have access to transit, since we have access to a reasonable estimate of this population from our analysis of the survey. In our analysis fewer than 30% of drivers to campus on an average day have reasonable access to transit (would add less than 15 minutes to their total commute). This then implies that for a 10% increase in the real price of parking, there is a 2% increase in the number of SOV trips taken by people who have access to transit switching to transit. This is equivalent to a direct "real" (i.e. transit minus parking price) price elasticity for transit of -0.2, which is a rather conservative estimate based on past studies of the MBTA. Essentially what this result says is that even if we double the price of parking, and leave the subsidy for transit unchanged, only 20% of the people who have access to transit will switch.

We have assumed that the Mobility Pass is perceived as the new price for transit, and thus the calculation of the decrease in costs is based on moving from the average annual price paid by commuter rail, LinkPass, and Bus Pass users to the total cost of the Mobility Pass.

It is not essential that we assume that the increase in transit demand is attributed to the same people on each day. That is, if we achieve a result that says demand for transit increases by 10%, we need not assume that 10% of people switch to transit 5 days a week, but rather we can assume that 50% of people switch to transit 1 day per week, or some combination of the two. As either of these scenarios has the same effect of reducing mode share by 10%, the net result is the same.

Cross price elasticity of demand for carpool with respect to the price of parking. Experience in Los Angeles has found that much of the gain in HOV share from differential pricing comes from reduced transit usage, as people who formerly took transit are "invited" by current drivers to drive to work with them. To mitigate this effect, we estimate the cross price demand for carpools with respect to the parking price only for those people who do not currently have access to transit. Because this population is exclusive to the population which we applied our direct price elasticity for parking to, it should eliminate this potentially confounding phenomenon.

While there seems to be a dearth of studies on the cross price elasticity of carpooling with respect to auto price, there are some studies that estimate the direct price elasticity of vanpooling is 1.5 [Wambalaba, Concas and Chavarria (2004)]. Since carpooling is now free, this would imply a 150% increase in the current carpools (or about 165 additional passengers and drivers each) that then would not be affected by the rates otherwise charged for parking. While this number does not seem so far off given a doubling in the average price of parking, it seems rather questionable given only a slight decrease in the parking charge for SOV. We have instead used a cross price elasticity of 0.05, which seems to give better results, but is not based directly on any past studies. The implication of this elasticity is that a doubling of the parking price will increase demand for carpooling by only 5%.

Because we have previously assumed that the Mobility Pass is perceived as the new price for transit we do not include it as a perceived cost of driving, and thus do not include it in the change in parking prices to which we apply our cross price elasticity of carpool demand.

Demand for guaranteed space in lot. We have assumed that no more than 10% of all drivers will choose to purchase an annual "guaranteed" space based on the projected pricing of these spaces.

Weekend charge. Due to the cost of operations on the weekend, this is assumed to be $0.

Current Average Daily Parking Price. We assume that people park on average 46 weeks per year, and thus their average daily cost for parking is equal to the annual cost divided by 230.

Current Average Annual Link and Bus Pass Cost. Based on the current distribution of Bus and Link Passes we have ascertained the average price that qualified participants currently pay for a non-commuter rail pass.

Current Average Annual Commuter Rail Pass Cost. We have assumed that the distribution of what zone commuter rail users will come from will not change. Thus, in estimating the affect of price change we have calculated the current average annual cost to purchase a commuter rail pass through MIT's subsidized program.

Depreciated Capital Cost of New Equipment. We assume an 8% real cost of capital and a 20 year lifespan for a one-time $500,000 capital cost to install new card readers at lots which do not currently have card readers.

6.4.2 Functional Forms

Revenue per year =

Transportation fee * (population – opt out) + Revenue per weekday * #weekdays parked per year + Revenue per weekend * #weekends parked per year +guaranteed annual price*# of guaranteed passes + revenue from qualified exempt population + depreciated capital costs of new equipment

Parking Revenue per day =

Average parking price * (current parkers – (# of switchers to transit + # switchers to carpool))

Total number of drivers switching to commuter rail =

Current number of drivers to campus with accessibility to mass transit * Current % commuter rail * (Elasticity of transit demand with respect to real parking price) * Percentage Change in Real Parking Price for Drivers with Commuter Rail Alternative

Total number of drivers switching to regular mass transit =

Current number of drivers to campus with accessibility to mass transit * (1 - Current % commuter rail) * (Elasticity of transit demand with respect to real parking price) * Percentage Change in Real Parking Price for Drivers with Regular Mass Transit Alternative

Percentage Change in Real Parking Price =
[(New Parking Price – New Transit Price) – (Current Parking Price – Current Transit Price)] / Current Parking Price

Total number of drivers switching to carpool =
Current number of drivers to campus without accessibility to mass transit * average parking price % change*cross price elasticity of demand for carpool with respect to parking price

Average Parking Price =
(Average Parking price high + Average parking price medium + Average parking price low) / 3

Average parking price (low) =
(Low price*(number of low spots) + Medium price*(number of medium spots) +Premium price* (projected number of parkers – number of low spots – number of medium spots)) / projected # of parkers

Average parking price (medium) =
(Low price*(number of low spots) + Premium price*(number of Premium spots) +Medium price* (projected number of parkers – number of low spots – number of premium spots)) / projected # of parkers

Average parking price (high) =
(Premium price*(number of premium spots) + Medium price*(number of medium spots) + Low price* (projected number of parkers – number of premium spots – number of medium spots)) / projected # of parkers

6.4.3 Sensitivity Analysis

6.4.3.1 Number of Weeks People Park in a Year

In our calculation we have assumed that people park 46 weeks per year. We believe that this assumption is relatively accurate, given vacation time and semester breaks. While some people will not park on campus at all over the semester breaks, many others will continue to do so every day. We can see that a 10% change in this assumption in either direction has a 27% change in carpool mode shift and an 18% change in transit mode shift. This translates to a $250,000 decrease in our subsidy calculations for every 10% change in the number of weeks people park per year, or a 3% change in total subsidy.

 # Weeks Sensitivity for Alternative 2a

Weeks Park Per Year	42	46	50
Current Drivers Switching to Transit	107	131	155
Current Drivers Switching to Carpool	40	55	71
Total MIT subsidy	$10,625,073	$10,333,950	$10,049,168
Additional subsidy from current	$729,024	$466,239	$209,795
Additional Subsidy from Current assuming no parking savings	$1,065,258	$891,647	$724,378

6.4.3.2 Mass Transit Demand Elasticity

We assume that the elasticity of demand for mass transit with respect to the real cost of parking is 0.2 (for every 10% increase in the price of parking or 10% decrease in the price of transit with respect to parking there is a 2% increase in demand). We find that a 25% decrease in this elasticity results in a decrease of 25% of SOV drivers switching to transit, not unsurprisingly. However, this has little effect on the required subsidy, increasing the required subsidy only $20,000, or 0.2%.

Mass Transit Demand Elasticity for Alternative 2a

Transit Demand Elasticity	**0.15**	**0.2**	**0.25**
Current Drivers Switching to Transit	98	131	163
Current Drivers Switching to Carpool	55	55	55
Total MIT subsidy	$10,351,064	$10,333,950	$10,316,835
Additional subsidy from current	$483,353	$466,239	$449,125
Additional Subsidy from Current assuming no parking savings	$834,106	$891,647	$949,187

6.4.3.3 Carpool Elasticity

We assume that demand elasticity for carpools with respect to the price of parking is 0.05 (a 10% increase in parking prices results in a 0.5% increase in the number of carpools). We find that a 50% decrease in this elasticity also decreases the number of predicted SOV drivers switching to carpool by 50%. However, due to the current low cost of carpools, this decrease only increases MIT's subsidy by $40,000, or less than 1%. Furthermore, if we do not include savings from foregone costs of providing parking, it actual decreases MIT's subsidy, as it increases parking revenue.

Carpool Elasticity for Alternative 2a

Car Pool Elasticity	**0.025**	**0.05**	**0.075**
Current Drivers Switching to Transit	131	131	131
Current Drivers Switching to Carpool	28	55	83
Total MIT subsidy	$10,371,420	$10,333,950	$10,296,479
Additional subsidy from current	$503,709	$466,239	$428,768
Additional Subsidy from Current assuming no parking savings	$865,723	$891,647	$917,570

6.4.3.4 Parking Demand

We have assumed that the middle demand for parking—wherein the low price and premium spots fill up first, and then the middle spots—will occur. If we relax this assumption it has an effect on our predicted mode switch and revenue because it affects the average cost of parking, on which our calculations of mode switch and revenue are based. We find that if the premium spots fill up last (associated with a lower average cost), 23% fewer people switch to mass transit, and 35% fewer people switch to carpool, with the inverse result if the low price spaces fill up last. This is equivalent to a $360,000 decrease in revenue or slightly less than 4%.

Parking Demand for Alternative 2a

Parking Demand	Premium Spots Last	Medium Spots Last	Low Spots Last
Current Drivers Switching to Transit	101	131	160
Current Drivers Switching to Carpool	36	55	74
Total MIT subsidy	$10,699,465	$10,333,950	$9,982,265
Additional subsidy from current	$831,754	$466,239	$114,554
Additional Subsidy from Current assuming no parking savings	$1,145,507	$891,647	$650,379

6.4.3.5 Access to Mass Transit

We have assumed an average of our low medium and high estimates for current drivers who have access to transit, which we have based on interpreting the difference in reported drive time based on the 2006 Transportation Survey data and predicted transit time based on their location and the transit network. We find that our transit mode shift is very sensitive to this assumption. Using our low estimate results in a 57% decrease in mode shift from SOV to transit, although this is slightly mitigated by more carpool users. However, these changes only increase the required subsidy by less than $30,000, since these people are now parking on a daily basis. Our high estimate has a similar effect in the opposite direction.

Access to Mass Transit for Alternative 2a

Access to Mass Transit	Low Estimate	Average Estimate	High Estimate
Current Drivers Switching to Transit	46	131	232
Current Drivers Switching to Carpool	69	55	39
Total MIT subsidy	$10,359,182	$10,333,950	$10,303,738
Additional subsidy from current	$491,471	$466,239	$436,027
Additional Subsidy from Current assuming no parking savings	$756,298	$891,647	$1,053,706

6.4.4 Detailed Calculations and Assumptions for Revenue forecasting

Current Parking Revenue

	#	Annual Rate	Current revenue
Regular Parking permits	3170	$638	$2,022,460
Occasional Parking permits	1374	$30	$41,220
Revenue From Occasional Spots			$325,888
Campus Resident	21	$638	$13,398
Carpool - Primary	109	$320	$34,880
Carpool - Secondary	110	$320	$35,200
Medical	23	$638	$14,674
Non-Employee Commuter	10	$759	$7,590
Prof Emeritus (Comp)	17	$638	$10,846
Prof Emeritus (w/o Comp)	93	$110	$10,230
Student Carpool - Primary	3	$228	$684
Student Carpool - Secondary	1	$228	$228
Student Commuter	79	$455	$35,945
Student Resident	499	$657	$327,843
Volunteer	4	$70	$280
Visitor			$223,000
Total			$3,104,366
Exempt From New Mobility Pass Rate			$696,362

Rates with 11% increase

	Mobility Pass	Annual fee	Revenue
Regular Parking permits	$15	$708	$2,244,360
Occasional Parking permits	$15	$33	$45,342
Revenue From Occasional Spots	$-		$325,888
Campus Resident	$15	$708	$14,868
Carpool - Primary	$15	$-	$-
Carpool - Secondary	$15	$-	$-
Medical	$-	$708	$16,284
Non-Employee Commuter	$15	$842	$8,420
Prof Emeritus (Comp)	$15	$708	$12,036
Prof Emeritus (w/o Comp)	$-	$122	$11,346
Student Carpool - Primary	$15	$-	$-
Student Carpool - Secondary	$15	$-	$-
Student Commuter	$15	$505	$39,895
Student Resident	$15	$729	$363,771
Volunteer	$0	$78	$312
Visitor			$223,000
Total			$3,305,522
Exempt From New Mobility Pass Rate			$669,476

Rates with Daily Prices

	Daily Rate Applies	Mobility Pass	Annual Fee	Revenue
Regular Parking permits	*	$15	$-	
Occasional Parking permits	*	$15	$-	
Revenue From Occasional Spots				
Campus Resident		$15	$708	$14,868
Carpool - Primary		$15	$-	
Carpool - Secondary		$15	$-	
Medical			$708	$16,284
Non-Employee Commuter	*	$15	$134	$1,340
Prof Emeritus (Comp)	*	$15	$-	
Prof Emeritus (w/o Comp)			$122	$11,346
Student Carpool - Primary		$15	$-	
Student Carpool - Secondary		$15	$-	
Student Commuter		$15	$505	$39,895
Student Resident		$15	$729	$363,771
Volunteer		$0	$78	$312
Visitor	*		$0	$223,000
Total				$670,816
Exempt From New Mobility Pass Rate				$669,476

Drive to Work Mode Share

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun	**Week Avg**	**Weekday Avg**	**Weekend Avg.**
Regular Park	3063	2995	3018	2963	2787	563	396	**2255**	**2965**	**479**
Occasional Park	345	340	374	380	353	98	133	**289**	**359**	**116**
All Other	698	634	644	650	657	605	593	**640**	**657**	

Space Allotment and Daily Drivers

	# of Spaces
Student	640
High	1084
Medium	1994
Low	980
Sum	4698
Daily Drivers	3324
Average Price	$2.77

Price changes at $2, $4, $6

	Price	Spaces Filled High Last	Daily Revenue	Spaces Filled Medium Last	Daily Revenue	Spaces Filled Low Last	Daily Revenue
High	**$6**	350	$2,099	1084	$6,504	1084	$6,504
Medium	**$4**	1994	$7,976	1260	$5,039	1994	$7,976
Low	**$2**	980	$1,960	980	$1,960	246	$492
Sum			$12,035		$13,503		$14,972
Average Price			$3.62		$4.06		$4.50
% change			31%		46%		62%

Price changes at $2, $6, $10

	Price	Spaces Filled High Last	Daily Revenue	Spaces Filled Medium Last	Daily Revenue	Spaces Filled Low Last	Daily Revenue
High	**$10**	350	$3,498	1084	$10,840	1084	$10,840
Medium	**$6**	1994	$11,964	1260	$7,559	1994	$11,964
Low	**$2**	980	$1,960	980	$1,960	246	$492
Sum			$17,422		$20,359		$23,296
Average Price			$5.24		$6.13		$7.01
% change			89%		121%		153%

Price changes at $2.25, $7

	Price	Spaces Filled High Last	Daily Revenue	Spaces Filled Medium Last	Daily Revenue	Spaces Filled Low Last	Daily Revenue
High	**$ 7.00**	350	$ 2,448	1084	$ 7,588	1084	$ 7,588
Medium	**$ 2.25**	1994	$ 4,487	1260	$ 2,834	1994	$ 4,487
Low	**$ 2.25**	980	$ 2,205	980	$ 2,205	246	$ 553
Sum			$ 9,140		$12,627		$12,627
Average Price			$ 2.75		$ 3.80		$ 3.80
% change			0%		37%		37%

Transit Alternatives

Estimate	Current Drivers	Viable Transit alt	No viable alt
Low	3324	332	2992
Medium	3324	816	2508
High	3324	1657	1667

Predicted Carpool switchers under low medium and high price scenarios, and low medium and high number of people who have access to transit

		$2,$4,$6			$2,$6,$10			$2.25,$7		
Access to Transit	**11% increase**	**L**	**M**	**H**	**L**	**M**	**H**	**L**	**M**	**H**
Low	16	46	69	93	133	181	228	0	55	55
Medium	14	38	58	78	112	151	191	0	46	46
High	9	25	39	52	74	101	127	0	31	31
Average	13	55			144			29		

% SOV drivers switching to transit: Commuter Rail and Bus or Subway

			$2,$4,$6			$2,$6,$10			$2.25,$7		
	Subsidy	**11% increase**	**L**	**M**	**H**	**L**	**M**	**H**	**L**	**M**	**H**
	50%	11%	15%	19%	22%	27%	33%	40%	9%	17%	17%
Commuter Rail	100%	41%	45%	48%	51%	57%	63%	70%	39%	46%	46%
Mass Transit	100%	6%	10%	13%	17%	22%	28%	35%	4%	11%	11%

Projected number of switchers

	11% increase		$2,$4,$6		$2,$6,$10		$2.25,$7	
Commuter Rail Subsidy	**50%**	**100%**	**50%**	**100%**	**50%**	**100%**	**50%**	**100%**
Commuter Rail	13	47	21	55	38	72	16	50
Mass Transit	51	51	110	110	232	232	73	73
Total	64	98	131	164	270	304	89	123

Annual Costs With 100% Commuter Rail Subsidy

		Alternative 1b	Alternative 2b	Alternative 3b	Alternative 4b
Parking Fees	**Current**	**11% increase**	**$2,$4,$6**	**$2,$6,$10**	**$2.25,$7**
Current Drivers Switching to Transit		98	164	304	123
Current Drivers Switching to Carpool		13	55	144	29
Percent of current Drivers Switching		-3%	-7%	-13%	-5%
Parking Daily Revenue	$9,053	$9,891	$12,609	$17,616	$10,939
Annual Mobility Pass Cost		$180	$180	$180	$180
On Campus Users Opt Out		2,092	2,092	2,092	2,092
Total participants w T Pass	5,011	16,341	16,341	16,341	16,341
Mobility Pass Revenue	$2,228,696	$2,941,380	$2,941,380	$2,941,380	$2,941,380
Additional Revenue from Off Campus Users	$61,937	$33,300	$33,300	$33,300	
Parking Revenue from Fees	$2,082,116	$2,274,991	$2,900,165	$4,051,584	$2,515,887
Parking Revenue from exempt and visitors	$696,362	$670,816	$670,816	$670,816	$670,816
Additional Revenue from occasional spots	$325,888	$325,888			
Guaranteed Spot Revenue			$149,569	$149,569	$149,569
Total Parking Revenue	$3,104,366	$3,271,695	$3,720,550	$4,871,969	$3,336,272
Total Revenue	**$5,394,999**	**$6,246,375**	**$6,695,230**	**$7,846,649**	**$6,277,652**
Spots required	4,814	4,703	4,594	4,366	4,661
Total Annual cost to provide parking	$11,000,000	$10,745,656	$10,497,385	$9,976,733	$10,651,383
Payment to MBTA w/out switchers	$4,142,995	$7,244,456	$7,244,456	$7,244,456	$7,244,456
Total cost of switchers	$-	$81,167	$135,985	$250,946	$101,808
Payment to MBTA for Off Campus Users	$119,715	$119,715	$119,715	$119,715	$119,715
Total payment to MBTA	$4,262,710	$7,445,337	$7,500,156	$7,615,117	$7,465,978
Additional Depreciated Admin costs			$58,415	$58,415	$58,415
Total Cost of Program	**$15,262,710**	**$18,190,993**	**$18,055,955**	**$17,650,265**	**$18,175,777**
Total MIT subsidy	**$9,867,711**	**$11,944,618**	**$11,360,725**	**$9,803,615**	**$11,898,124**
Additional subsidy from current		$2,076,908	$1,493,014	$(64,095)	$2,030,413
Additional Subsidy from Current assuming no parking savings		$2,331,252	$1,995,630	$959,172	$2,379,030

Annual Costs With 50% Commuter Rail Subsidy

		Alternative 1a	Alternative 2a	Alternative 3a	Alternative 4a
Parking Fees	**Current**	**11% increase**	**$2,$4,$6**	**$2,$6,$10**	**$2.25,$7**
Current Drivers Switching to Transit		64	131	270	89
Current Drivers Switching to Carpool		13	55	144	29
Percent of current Drivers Switching		-2%	-6%	-12%	-4%
Parking Daily Revenue	$9,053	$9,995	$12,747	$17,823	$11,055
Annual Mobility Pass Cost		$180	$180	$180	$180
On Campus Users Opt Out		2,122	2,122	2,122	2,122
Total participants w T Pass	5,011	16,311	16,311	16,311	16,311
Mobility Pass Revenue	$2,228,696	$2,935,980	$2,935,980	$2,935,980	$2,935,980
Additional Revenue from Commuter Rail Users		$577,667	$577,667	$577,667	$577,667
Additional Revenue from Off Campus Users	$61,937	$48,549	$48,549	$48,549	$48,549
Parking Revenue from Fees	$2,082,116	$2,298,919	$2,931,737	$4,099,186	$2,542,694
Parking Revenue from exempt and visitors	$696,362	$670,816	$670,816	$670,816	$670,816
Additional Revenue from occasional spots	$325,888	$325,888			
Guaranteed Spot Revenue			$149,569	$149,569	$149,569
Total Parking Revenue	$3,104,366	$3,295,623	$3,752,122	$4,919,571	$3,363,079
Total Revenue	$5,394,999	$6,857,819	$7,314,318	$8,481,767	$6,925,275
Spots required	4,814	4,736	4,628	4,400	4,695
Total Annual cost to provide parking	$11,000,000	$10,822,864	$10,574,592	$10,053,941	$10,728,591
Payment to MBTA w/out switchers	$4,142,995	$6,787,496	$6,787,496	$6,787,496	$6,787,496
Total cost of switchers	$-	$53,231	$108,049	$223,010	$73,872
Payment to MBTA for Off Campus Users	$119,715	$119,715	$119,715	$119,715	$119,715
Total payment to MBTA	$4,262,710	$6,960,442	$7,015,261	$7,130,222	$6,981,083
Additional Depreciated Admin costs			$58,415	$58,415	$58,415
Total Cost of Program	**$15,262,710**	**$17,783,306**	**$17,648,268**	**$17,242,577**	**$17,768,089**
Total MIT subsidy	**$9,867,711**	**$10,925,486**	**$10,333,950**	**$8,760,811**	**$10,842,814**
Additional subsidy from current		$1,057,776	$466,239	$(1,106,900)	$975,103
Additional Subsidy from Current assuming no parking savings		$1,234,912	$891,647	$(160,841)	$1,246,512